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Atomic Energy Control Board
Commission de contrôle de l'énergie atomique

INFORMATION BULLETIN 89-1 March 15, 1989

REGULATORY RESEARCH & SUPPORT PROGRAM FOR 1989/90 -- PROJECT DESCRIPTIONS

The Regulatory Research & Support Program is intended to augment and extend the Atomic Energy Control Board's regulatory program beyond the capability of in-house resources. The overall objective of the research & support program is to produce pertinent and independent information that will assist the Board and its staff in making correct, timely and credible decisions on regulating nuclear energy.

The program is divided into eight main areas of research covering the safety of nuclear facilities, radioactive waste management, health physics, physical security and the development of regulatory processes. A total of 83 projects are planned for 1989/90, including a number which are ongoing from the previous fiscal year. Projects that are held in reserve in case funding becomes available are also listed.

Most of the projects will be carried out under contracts issued through the Department of Supply and Services.

This Information Bulletin contains a list of the projects with a brief description of each, and additional supporting information.

Additional copies of this Bulletin, or other information concerning its contents, may be obtained by contacting:

Atomic Energy Control Board
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Ottawa, Canada
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92-00796/

REGULATORY RESEARCH & SUPPORT PROGRAM 1989/90

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1989/90 PROJECT DESCRIPTIONS

2. NUCLEAR REACTORS

EXPLANATION OF PROJECT DESCRIPTIONS

A. PROJECT NUMBER (unique to project)

- first digit	number of the Mission Object (see main headings in "List of 1989/90 Projects", numbered from 2. Nuclear Reactors to 9. Regulations and Regulatory Process Development)
- second set of digits	item number (beginning nominally with number 101) within the Mission Object
- third digit	contract or phase number in a sequence of related contracts for a given item number (e.g., a full-scale study [2] following a feasibility study [1]). The number 1 appears even if a project is not subdivided into phases.

B. TITLE

C. SUMMARY

The three paragraphs state:

- WHAT is proposed or in progress and by what means
- WHY this project is proposed
- HOW it is intended to use the results.

The participation, if any, of other organizations is also mentioned.

D. PROPONENT

Originating division within the AECB, or other originator, of the proposal. (Abbreviations refer to AECB organizational units, whose full names are given under "Standard Abbreviations, AECB Organizational Units".)

E. TECHNICAL ADVISOR/EVALUATOR

AECB division (and individual staff member, where known) which gives advice to, or for liaison with, the Project Manager on certain technical aspects of the project. The evaluator assesses the quality of the work done by the contractor and also assesses how the results of the project may be used by the AECB, through a post-project evaluation.

F. PROJECT MANAGER

Name of staff member within the Research Sections responsible for the project (to the extent that the AECB is committed, in the case of joint projects).

G. REVIEW PANEL

The Review Panel is a group of internal and external experts set up by the AECB to give advice to the Project Manager on some or all technical aspects of the project. A panel is automatically included in the post-project evaluation, even if not so shown in block E.

H. CONTRACTOR

For projects in progress, the name of the company or institution doing the work is given.

I. PRINCIPAL INVESTIGATOR

If known, the name of the principal investigator is given.

J. CATEGORY

1* - Projects in progress at the beginning of the program year.
1 - Projects intended to be initiated in the program year.
2 - Projects which would be Category 1 but depend on the outcome of other work, e.g., on the results of a feasibility study.
3 - Projects deferred to next or subsequent years or held in reserve in the event that funds become available in the program year.

K. FUNDING

Past Years	Year Prior to Program Year	Program Year	Year after Program Year	Future Years	Project Total

- Actual expenditures are shown for past years.
- Budgeted amount is shown for the program year; but this amount is subject to change. For Categories 2 and 3 items the amount may be quite speculative.
- Amounts shown for years after the program year can be very speculative.

L. RELATED PROJECTS

Earlier directly-related projects are shown by project number along with the previous expenditures, by year, on such projects. Directly-related projects may be literature reviews, feasibility or pilot studies, or earlier phases of a project consisting of more than one contract in series.

1989/90 PROJECT DESCRIPTIONS

2.089.2 Computer Software Quality Assurance (II)

It is proposed to obtain consulting services concerning quality assurance for analytical software used in nuclear power reactor engineering. The consultant would review the types of analytical software to be covered by the proposed Canadian Standards Association (CSA) quality assurance standard in the N286 series and recommend to AECB staff appropriate quality assurance approaches and procedures for the design, development and maintenance of such software.

AECB staff are participating in a CSA committee to establish a quality assurance standard in the N286 nuclear series applicable to analytical software such as codes to simulate thermohydraulic processes or software tools to perform Computer Aided Design. This has been recently identified as an area where the AECB should increase its involvement. The AECB does not have sufficient in-house expertise available concerning software quality assurance and software engineering hence the need for external assistance.

This activity will provide independent advice to enable the AECB to contribute more effectively to the N286 analytical software committee.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (D. Scrimger)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

2.089.1	$20000	$0	$0			$20000

2.101.1 Instrument Behaviour under Off-Normal Conditions

It is proposed to conduct a study on the behaviour, during and after selected hypothetical severe accident conditions, of instruments used in CANDU reactors. Emphasis would be placed on the accuracy of thermocouples, pressure transducers and flow meters during and after being forced to operate at the extremes of, or outside, their scales.

Information on instrument behaviour during and after severe accident conditions is scarce. This work, therefore, would generate new knowledge necessary to improve the understanding of instrument readings during and after abnormal events.

The results of this study would be used in assessing licensee assumptions and interpolations regarding accident scenarios described by instrument-reading records.

Proponent	SSS, SED
Technical Advisor/Evaluator	SED (B. Finigan)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

2.102.1 A Tool to Analyze Real-Time Programs

A project is proposed to survey the latest developments in computer program analysis and testing, using graph theory as applied to real-time critical systems. Then, based on the results of the survey, it is proposed to acquire or develop a program graphing software tool to analyze the complexity and verification/validation test coverage aspects of safety-related nuclear system software.

Due to the combination of the number of inputs and processing pathways, computer programs used to control nuclear reactor systems are very difficult to verify and validate to an acceptable degree of confidence. Even using extensive test data some design and programming faults may go undetected resulting in the possibility of a critical failure at some future time given a certain set of input and processing conditions.

The results of the survey phase would provide AECB staff with the latest information concerning analysis of critical software, enabling a knowledgeable assessment of the particular methods and test data used by licensees to verify and validate their nuclear software. The resulting software tool may provide an effective means for AECB staff to rigourously and independently evaluate the testability of a particular system and the extent of test coverage proposed by the licensee.

Proponent	SED, SSS
Technical Advisor/Evaluator	SED (J. Kendall)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$60k	$0k	$0k	$60k

Earlier Directly-Related Contracts and Funding:

2.105.1 Crack Propagation in Tough Ductile Materials

It is proposed: a) To perform experimental work which would examine elastic-plastic fracture behaviour in steels which are typical of materials used in CANDU primary heat transport systems; and to explore whether small specimen tests can be used to characterize "lower bound" crack behaviour under the range of elastic-plastic strain conditions encountered in CANDU primary heat transport system components (Phase 1). b) To evaluate the effectiveness of crack displacement and energy based fracture toughness methods of describing crack propagation behaviour under elastic-plastic strain conditions. This should include studies of the individual approaches and an investigation into the viability of a combined energy and crack displacement approach as a route towards a representative model for a wide range of crack growth (Phase 2).

The project arises from the recommendations of a recently completed review of crack and fracture behaviour in tough, ductile materials (84.1.38), which showed a need to incorporate elastic-plastic fracture mechanics considerations into the analysis and design of metallic structural components. The project is aimed at the eventual development of a practical method for the analysis and assessment of stable crack growth under elastic-plastic strain conditions.

The results of the project would be used as reference information to enable more effective appraisal of safety margins in defect dispositioning and other crack stability assessment work.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (J.K. Pereira)
Project Manager	J. Pachner
Review Panel	
Contractor	University of Toronto
Principal Investigator	R.D. Venter
Category	1*

Past	88/89	89/90	90/91	Future	Total
$60k	$20k	$10k	$0k	$0k	$90k

Earlier Directly-Related Contracts and Funding:

84.1.38	$25000	$0	$0			$25000

2.105.2 Crack Propagation In Tough Ductile Materials - Carbon Steel

It is proposed to examine the results of carbon steel fracture toughness tests and pipe rupture experiments, and to formulate a theory describing the observed crack behaviour. In addition, it is proposed to evaluate whether the crack growth model which accounts for angled crack propagation is more or less conservative than the classical fracture mechanics approach.

Recent testing performed in the IPIRG program (see project 2.111.1) has shown that crack growth in carbon steel piping material is not across the plane of principal stress, but runs at a sharp angle (approximately 45°) to it. However, current pipe rupture analyses, using linear-elastic or elastic-plastic fracture mechanics, assume that cracks propagate circumferentially to produce a plane-ended guillotine break. These analyses are used in licensing submissions for defect disposition and to demonstrate leak-before-break behaviour. The proposed project would address this discrepancy between the theory and actual crack growth behaviour.

The results of the project would serve as a technical basis for defect dispositioning and other crack stability assessment work and would be used in the assessment of licensing proposals in this area.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (B. Jarman)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	2

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

2.105.1	$69000	$30000	$0	$99000
2.111.1	$13000	$140000	$0	$153000

2.108.1 Survey of NPP Environments for Equipment Qualification

It is proposed: a) to determine the expected type and range of actual plant environments (in selected plants and plant areas) to which various safety-related equipment and components are normally exposed during their service life; and b) to assess if the currently used accelerated aging methods account for these environments. The contractor would obtain available data on measured plant environments (e.g. radiation, thermal, mechanical stress, gas) and, as necessary, would measure actual environments during plant operation in selected plants and plant areas, and would assess the type and range of the environments and their simulation by the currently used accelerated aging methods.

To assure a conservative basis for equipment qualification testing, equipment should be tested in a state equivalent to the end-of-qualified life condition. Since it is not practical to naturally age equipment to the end-of-life condition, accelerated aging techniques are used to change the equipment to be tested to a state equivalent to end-of-life. To be able to simulate natural aging, actual plant environments must be known.

The project results would enable AECB staff to assess whether the accelerated aging methods reported in EQ licensing submissions adequately account for normal NPP environments.

Proponent	SSS, PRDA&B
Technical Advisor/Evaluator	PRDA (R. Leblanc)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

2.111.1 International Piping Integrity Research Group

It is proposed to continue membership in the International Piping Integrity Research Group (IPIRG). This group, organized by the U.S. Nuclear Regulatory Commission (USNRC), is examining the fracture behaviour of large piping systems. The proposed program by the USNRC includes: fracture tests done on approximately 60 large-diameter pipes, of which about one third are directly relevant to CANDU; material tests to establish a data base for fracture analysis; assessment of the efficacy of fracture calculations; review of degraded piping; and review of the state-of-the-art analytical and experimental developments. The cost of Canadian participation in the IPIRG program would be shared equally between AECB and Ontario Hydro (each contributing $420K).

There is a need to develop and verify the technology to justify: using analytical assessments to disposition piping defects and prescribe inspection frequencies for them; permitting leak-before-break concepts in lieu of mechanical protection for hypothetical pipe ruptures; and current procedures for response to primary heat transport system leaks.

The results would be used to support, or change, the licensing criteria for protection against pipe rupture, to define in-service inspection frequencies, and to develop rules for reactor shutdown after leaks have been detected.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (B. Jarman)
Project Manager	A. Omar
Review Panel	
Contractor	USNRC/Battelle
Principal Investigator	M. Mayfield/A. Taboada
Category	1*

Past	88/89	89/90	90/91	Future	Total
$132k	$129k	$140k	$0k	$0k	$401k

Earlier Directly-Related Contracts and Funding:

2.114.2 A Simulator for Evaluating Emergency Operating Procedures

A research project is proposed which would produce a series of computer modules which simulate the general dynamic features of a CANDU 600 MW reactor. The modules would "plug in" to the existing computer simulation environment which was acquired by project 2.114.1.

This project is prompted by a review of Emergency Operating Procedures (EOP) that indicated the need for an analytical tool to assist in understanding the interaction of various plant systems. For example, during a small LOCA involving the steam space above the pressurizer at low power, one would expect the pressure to drop quickly and the pressurizer level to drop by about 10% and then rise rapidly. At full power, the pressurizer level should rise as the pressure drops. Such an hypothesis could be tested with this simulation.

The simulation will be used to develop an understanding of the way in which a CANDU 600 MW reactor responds to various accident conditions. This understanding is required to evaluate the suitability of the form and diagnostics in an EOP.

Proponent	SED
Technical Advisor/Evaluator	SED (J.D. Kendall)
Project Manager	D.J. Martin
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$20k	$20k	$0k	$0k	$40k

Earlier Directly-Related Contracts and Funding:

86.1.24	$30000	$0	$0			$30000

2.117.1 Documentation of Real-Time Power Reactor Software (I)

It is proposed to survey software documentation standards and practices applicable to real-time systems and identify documentation techniques and elements that would be effective over the entire life cycle of CANDU computer-based process control and safety systems. This project would be initiated following completion of 2.127.2 to derive full benefit from, and to consolidate the particular experience of, 2.127.1 and 2.127.2.

Real-time software is being applied extensively both in the newer CANDU power stations and for retrofitting older stations. In addition, existing operational software must undergo many changes throughout its operational phase to correct faults and to adapt to additional requirements. To further complicate the situation, the electrical utilities will likely be left responsible for software system support as their system supppliers and consultants are forced by economic pressures to reduce their activities in this area.

The results of this study would assist AECB staff in assessing the adequacy of documentation for real-time software systems in use and proposed in CANDU nuclear power stations.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Kendall), CQAD (M. Massicotte)
Project Manager	D.E. Connelly
Review Panel	12
Contractor	Queen's University
Principal Investigator	D. Parnas
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

2.117.2 Documentation of Real-Time Power Reactor Software (II)

It is proposed to provide additional independent expert input to project 2.117.1 concerning the background and rationale for the criteria defined in IEC Standard 880, "Software for Computers in Safety Systems of Nuclear Power Stations".

Experts at the AECB and regulatory agencies in other countries consider IEC-880 to be perhaps the most suitable standard available for use in safety critical applications. Project 2.117.1 will review IEC-880 for applicability to Canadian conditions taking into account the experience gained with projects 2.127.1 and 2.127.2 as well as recent research in software engineering and structured programming. As this work will likely have significant impact on nuclear reactor licensing in Canada it is essential that additional independent expertise be available to ensure that sufficient consideration has been given to all the issues.

This activity would improve the completeness and efficacity of the work being done in project 2.117.1.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Kendall), CQAD (M. Massicotte)
Project Manager	D.E. Connelly
Review Panel	
Contractor	Gesellschaft fur Reaktorsicherheit (GRS) mbH
Principal Investigator	Dr. W.D. Ehrenberger
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$10k	$15k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

2.117.1	$0	$0	$30000			$30000

2.118.1 Behaviour of the Calandria Structure under Severe Conditions

It is proposed to conduct an analytical study to investigate the survivability of the calandria structure under a hypothetical rapid increase in the temperature and pressure of the moderator.

It is uncertain how the calandria structure would eventually fail when subjected to a rapid increase in the temperature and pressure of the moderator. If the upper portion of the calandria (i.e. the reactivity mechanism deck) were to fail first, this would result, in certain CANDU designs, in a breach of containment. Information is needed, therefore, to determine the consequences of such a hypothetical situation and then, if necessary, the measures which would be required to prevent or mitigate its consequences.

The results of this project would expand the knowledge base of AECB staff and augment their understanding of the behaviour of a CANDU reactor under a combination of hypothetical human errors and systems responses.

Proponent	SED, PRD
Technical Advisor/Evaluator	CQAD (B. Jarman)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$90k	$0k	$0k	$90k

Earlier Directly-Related Contracts and Funding:

2.122.1 Non-Uniformity of Hydrogen in Fuelling Machine Vaults

It is proposed to determine the extent of the non-uniformity of hydrogen concentration in a fuelling machine vault following a LOCA and LOCA with LOECC. The work would involve flow visualization and measurement of spatial distribution of hydrogen concentration as a function of time in a 1:10 to 1:20 scale model of the Pickering fuelling machine vault used as a typical case. The location of the hydrogen source, the rate of hydrogen discharge and the hydrogen/steam ratio are the parameters which would be studied.

Current research on hydrogen burn in the fuelling machine vault is aimed at developing a technical basis for predicting the consequences of the burn in terms of pressure and temperature rise in the vault. Important characteristics such as flammability limits, flame propagation and transition to detonation are being investigated, however, burning in non-uniform mixtures has not been addressed. Since hydrogen burning and hence its consequences could be strongly dependent on the hydrogen concentration non-uniformities, it is necessary to determine whether significant non-uniformities could exist in the fuelling machine vault following a LOCA and LOCA with LOECC despite the mixing of gases by the vault cooling fans.

Results of this research would determine whether hydrogen burning in non-uniform mixtures should be investigated in order to predict realistic consequences of hydrogen burn in the fuelling machine vault.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Khosla)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

2.123.1 Effect of Geometry on Hydrogen Burn in Calandria

It is proposed to investigate the burning characteristics of hydrogen in the calandria under conditions of low moderator level. The work would involve measurements of hydrogen burning rate and flame velocities in the axial and lateral directions using representative mixtures of hydrogen, helium, steam and oxygen in a full to 1:10 scale model of the upper segment of the calandria vessel which would include both the calandria and reactivity mechanism tubes.

Current hydrogen combustion research includes studies related to hydrogen burn in the calandria which could occur following postulated events involving drop of moderator level below the top row of calandria tubes. Deuterium evolution, flammability and detonation limits, ignition and other characteristics are being investigated, however, hydrogen burning in actual calandria geometry is not being addressed and this is a factor which is likely to significantly influence hydrogen burning rate and propagation, and consequently the event sequences.

The results of the research would enable the AECB staff to assess whether the consequences of hydrogen burn predicted on the basis of tests in simple geometries are representative of those likely to occur in the calandria.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Khosla)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

2.127.3 Evaluation of Computerized Shutdown System Software (III)

It is proposed to evaluate the safety and reliability aspects of the software used in the trip computers of the Safety Shutdown Systems for the Darlington Nuclear Generating Station. The previous two phases reviewed the software structural level for both shutdown systems. Phase 3 would consist of the following activities for the trip computer software of Shutdown Systems 1and 2: a) determine the most effective methods to evaluate in detail the system at the programming level from the viewpoint of safety, based on the documentation available and the system's characteristics; and b) use these methods to carry out the safety evaluation.

All of the Darlington Shutdown System functions have been implemented in software hence the safety of the station is highly dependent on the safe execution of this software. Due to the large number of inputs and processing pathways it is not sufficient to rely solely on verification and validation testing to assure fault detection to an acceptable degree of confidence. Analysis of the safety aspects of the software is essential to detect complex and subtle design and implementation errors and to determine if the licensee's testing effort resources have been focussed on the critical areas.

The results of this study will be used by AECB staff in assessing the software integrity of the Darlington shutdown systems.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Kendall)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$15k	$35k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

2.127.1	$31000	$0	$0			$31000
2.127.2	$57000	$0	$0			$57000

2.127.5 Evaluation of Computerized Shutdown System Software (V)

It is proposed to develop a procedure for using statistical testing to evaluate the probability that a critical real-time software system (such as the proposed shutdown systems for Darlington Nuclear Generating Station) meet its requirements. This project is an elaboration of the preliminary recommendations made in projects 2.127.2 and 2.127.4 concerning statistical testing.

For safety-critical systems it is essential that an estimate of the upper bound of the probability of failure be determined before the system is placed in service. By applying N statistically valid, randomly selected test cases, we can determine the likelihood that a system with a probability of failure greater than a certain value would successfully pass the N tests. Then by selecting an acceptable upper bound for the probability of failure, the number of test cases required, N, can be derived and applied resulting in a tangible numeric estimate of the trustworthiness of the system.

The results of this work will assist AECB staff in preparing recommendations for regulatory actions concerning the proposed trip computer software for the Darlington shutdown systems.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Kendall)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

2.127.1	$31000	$0	$0	$31000
2.127.2	$67000	$5000	$0	$72000
2.127.4	$8000	$0	$0	$8000
2.127.6	$0	$25000	$0	$25000

2.129.1 Meteorological Monitoring Network for Pickering NGS

It is proposed that weather data on wind speed, direction and stability, as defined in the draft AECB staff position on meteorological monitoring standards, should be obtained for the Pickering NGS. This would be a joint project between AES (Atmospheric Environment Service of Environment Canada) and AECB using a meteorological monitoring network installed and operated by AES.

This work is proposed because of the desirability of having site specific weather data, not only for emergency response and containment venting strategies but also for safety analyses in view of the uncertainties which exist in the methodologies used to derive "simulated" weather scenarios.

The results of this project will be used, in accordance with the latest version of CSA Standard N288.2, to validate the "simulated" weather scenarios submitted by Ontario Hydro for use in safety analyses. Furthermore, this project will form a basis for estimating the cost of obtaining site specific weather data to be used in safety analyses as proposed in the draft AECB staff position on meteorological monitoring standards.

Proponent	SED (L. Truong)
Technical Advisor/Evaluator	SED (L. Truong)
Project Manager	D.J. Martin
Review Panel	
Contractor	Environment Canada (AES)
Principal Investigator	P. Taylor
Category	1*

Past	88/89	89/90	90/91	Future	Total
$9k	$5k	$4k	$0k	$0k	$18k

Earlier Directly-Related Contracts and Funding:

2.129.2	$0	$0	$10000			$10000

2.130.1 Self-Testing of Programmable Controllers & Microcomputers

It is proposed to initiate a two phase project to develop guidelines for the review of self-test systems in custom engineered programmable controllers (PCs) and industrial microcomputers (IMs) used in safety related and special safety control systems for CANDU nuclear power stations. The first part of the project would review the current and proposed equipment and similar off-the-shelf manufactured products, along with the particular electronic technologies applied to identify the possible hardware failure modes and to develop a description of the hardware faults to be detected by an adequate self-test system. The second part would describe, in detail, methods to detect the hardware faults identified in Phase I, would develop a comprehensive checklist and set of guidelines for self-tests that are dependent on the particular electronic technology used, and would, as an illustrative example, evaluate the systems from the first part using these guidelines.

The use of PCs and IMs is extensive in CANDU nuclear power stations both in new stations and for the retrofitting of older units. This technology involves a complex blend of real-time software and high performance microcircuit devices for which the realability history is limited. Guidelines are required to allow AECB staff to evaluate the adequacy of the self-test systems with respect to fault detection and the contribution to overall reliability.

The results of this project would assist AECB staff in the assessment of the self-test methods used in the shutdown systems at Darlington Nuclear Generating Station and in the OH-180 Programmable Controllers used throughout Darlington's safety related control systems.

Proponent	SED
Technical Advisor/Evaluator	SED (B. Finigan, J. Kendall), PRD-B (I. Lee)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$70k	$0k	$0k	$70k

Earlier Directly-Related Contracts and Funding:

2.132.1 Review of Software Configuration Management at Darlington

It is proposed to review the Software Configuration Management systems to be used to manage the software configuration for the reactor control computers, safety shutdown systems and the programmable controllers used at Darlington Nuclear Generating Station.

Darlington will make extensive use of real-time software in numerous mini and microcomputers at different revision levels and in many different configurations. For example, the OH-180 programmable controllers have a hierarchy of four levels of interacting software with the lower level consisting of approximately 500 different application programs. In such a situation, careful management of software changes is essential to safety.

The results of this project will be used by AECB staff in evaluating the safety aspects of the application of computers to special safety systems and safety related systems.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Kendall), CQAD (M. Massicotte)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

2.109.1	$20000	$0	$0			$20000

2.133.1 Review of the SLOWPOKE Demonstration Reactor Control System

It is proposed to review the control system for the SLOWPOKE Demonstration Reactor (SDR) to determine whether the proposed system configuration is appropriate for safe operation.

The dynamics of the SDR are characterized by a number of very long time constants, time delays and non-linearities. Therefore the design criteria and techniques commonly used for conventional nuclear reactor control systems may not be applicable.

This work will assist AECB staff in evaluating the ability of the design methods used for the SDR control and safety systems to take into account the full range of normal and abnormal operating conditions.

Proponent	SED
Technical Advisor/Evaluator	SED (B. Finigan, J. Kendall)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$35k	$0k	$0k	$35k

Earlier Directly-Related Contracts and Funding:

2.134.1 Estimating Software Reliability for Reactor Shutdown Systems

It is proposed to initiate a multi-phased project that would address the question of estimating the contribution of the software to the unavailability of the Darlington trip computer systems. The project would be carried out in the following parts: 1) determine whether it would be technically feasible to estimate, to an acceptable degree of confidence, the contribution of the software to the unavailability of the shutdown systems 2) if feasible, estimate the unavailability contribution for Shutdown System 1; and 3) repeat part 2 for Shutdown System 2.

The current unavailability analyses for the Darlington Shutdown Systems do not include the software contributions. Experience with similar critical software systems in aerospace and telecommunication applications indicates that the software contributions to system unavailability could be significant.

The results of this study would assist AECB staff in evaluating the Probability Safety Analyses for the Darlington Shutdown Systems.

Proponent	SED
Technical Advisor/Evaluator	SED (B. Finigan, T. Leung, J. Kendall)
Project Manager	D.E. Connelly
Review Panel	12
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$75k	$75k	$0k	$150k

Earlier Directly-Related Contracts and Funding:

2.127.1	$31000	$0	$0			$31000
2.127.2	$57000	$0	$0			$57000

2.135.1 In-Service Degradation of NPD Heat Transport Piping

It is proposed to determine the extent of degradation present in the NPD reactor primary heat transport system piping after 25 years in service. The work would involve selection of appropriate piping samples, collection of relevant design, operational and maintenance data, inspection, removal and laboratory tests to assess possible damage caused by erosion, corrosion and other degradation mechanisms. Measured material strength and fracture toughness parameters, which characterize load-bearing capability of carbon steel in pipes and welds, would be compared with ASME code data and baseline data, if available. This would be a joint project with Ontario Hydro with a total cost of approximately $90K.

Materials used for the NPD primary heat transport piping system comprise mainly ferritic steels which were selected from a range of standard steel materials. In other words, they have not been specially qualified or developed for a nuclear service type duty. The proposed evaluation of their behaviour/degradation after 25 years of nuclear service would provide useful information related to the development of life expenditure models, their current fitness for service, and the merit of the material selection criteria used.

Results of the proposed work would in general contribute to the current understanding of degradation of carbon steel piping and welds in long-term nuclear service, and especially would improve the AECB capability to assess expected licensees' submissions related to the use of high grade commercial piping in nuclear service.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (J.K. Pereira)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$17k	$0k	$0k	$17k

Earlier Directly-Related Contracts and Funding:

2.136.1 Commercial Pressure Retaining Components in Nuclear Service

It is proposed to review practices for qualification and acceptance of high grade commercial components for pressure-retaining system service. The focus is to be directed at components which are not designed for specific applications but which are available for selection from standard product lines.

The reduction, in recent years, in the number of nuclear power projects being actively pursued has led to the withdrawal, from the market, of many manufacturers and suppliers of 'nuclear grade' components. The utilities have thus been driven to seek alternative sources for certain categories of components. One option being explored for certain applications is to utilize high grade commercial components which come from standard product ranges with a proven record of quality and reliability. This project seeks to examine component qualification practices used for such components, for comparison with requirements for nuclear system service.

The results of the review would give technical background information for use in assessing the merits of proposals to use high grade commercial components in nuclear pressure retaining service applications.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (J.K. Pereira)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

2.137.1 Hydrogen Combustion in Calandria

It is proposed to assess the validity of the assumptions made in the safety analysis, and of the predicted consequences, of a hydrogen burn inside the calandria. The work would include assessments of the type of hydrogen burn, the flame velocity (and its dependence on the presence of calandria internals), and the effect of venting. In addition, a review of the industry research program would be conducted to determine whether additional research work is required.

The concentration of hydrogen in the cover gas space in the calandria may increase following a loss of moderator level control or a break in the moderator system. The fall in the moderator level may also result in increasing the temperature of some of the reactivity mechanism devices (in particular cobalt adjusters) and thus form a heat source for the ignition of hydrogen. The predicted consequences of a hydrogen burn inside the calandria, including the peak pressure, are sensitive to the assumptions made. An expert assessment of the licensee's analysis, including the validity of the assumptions made, is needed as an input to the AECB licensing process.

This assessment would help the AECB in making regulatory decisions related to the predicted consequences of a loss of moderator inventory accident. In addition, the assessment of the adequacy of the industry's research program would provide the technical basis for possible improvements to the program.

Proponent	SED
Technical Advisor/Evaluator	SED (J.K. Khosla)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$15k	$0k	$0k	$15k

Earlier Directly-Related Contracts and Funding:

2.139.1 Aging of Cables in Nuclear Power Plant Environments

It is proposed to determine the functional capability of naturally aged and further artificially aged cable samples under LOCA and post-LOCA conditions. The work would involve selection of appropriate electrical/instrumentation cables, collection of data on experienced service environment, and laboratory tests and assessments at Ontario Hydro Research. This would be a joint project with Ontario Hydro with a total cost of $30,000.

In a radiation environment, the predominant failure mode of electrical control and power cables is the embrittlement of the insulation resulting in the rupturing or cracking of the insulation during temperature cycling or cable movement. Initial qualification of electrical and instrumentation cables for service in NPP environments involves simulation of actual aging tbefore testing under postulated accident and post-accident conditions. Cable samples obtained from NPD NGS, which has been permanently shut down after 25 years of service, provide a unique opportunity to extend the understanding of field aging of insulating materials and to determine operability and degradation of the cables under accident conditions.

Results of the proposed work would advance state-of-the-art knowledge related to qualification of cables, their aging under actual plant conditions, and would improve the AECB capability to assess the effectiveness of licensees' equipment qualification programs for electrical/instrumentation cables.

Proponent	SSS, SED
Technical Advisor/Evaluator	SED (T. Leung)
Project Manager	J. Pachner
Review Panel	
Contractor	Ontario Hydro, Research Division
Principal Investigator	D.J. Stonkus
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$10k	$5k	$0k	$0k	$15k

Earlier Directly-Related Contracts and Funding:

2.143.1 Mapping of NPD Rolled Joint Hydrides

It is proposed to sponsor a project to map the density and orientation of zirconium deuteride platelets in the rolled-joint region of an NPD pressure tube by sectioning the tube at the Zircaloy-steel interface.

Deuterium ingress, leading to deuteriding of the rolled-joint region of CANDU reactor pressure tubes, is a problem which is expected to lead to tube failures. The zircaloy tubes in NPD are believed to be heavily deuterided, but none have failed in service. Examination of such a tube could lead to: a) confirmation of current models of deuterium ingress; b) understanding of migration paths and platelet formation; and c) ability to predict material integrity from platelet orientation.

The results of the project could lead to confirming existing or developing new hypotheses about the integrity of pressure tubes in mature reactors. These would permit AECB staff to better assess predictions of pressure tube life expectancy.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (B. Jarman)
Project Manager	J. Pachner
Review Panel	
Contractor	Atomic Energy of Canada Ltd. - CRNL
Principal Investigator	J. Slade
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$34k	$10k	$0k	$0k	$44k

Earlier Directly-Related Contracts and Funding:

2.146.1 Cold-Water Injection Loading in Two-Phase Systems

It is proposed to conduct a critical review of information related to the service experience of loadings arising from cold coolant injection into a system containing two-phase fluid and the thermalhydraulic behaviour that causes such loadings.

There have been several occurrances of significant load transients arising from interactions between cold coolant and two-phase environments. A recent incident involving the Bruce Unit-8 deaerator forms part of the CANDU reactor experience of such load transients. The project will enhance AECB understanding of the phenomena involved and will aid appraisal of the conditions necessary for the effective operation of safety systems.

The project will provide information with which to determine the ability of reactor system components to sustain dynamic loads which are likely to arise during the operation of coolant injection systems.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (K. Pereira), SED (Q.S. Truong)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$20k	$15k	$0k	$0k	$35k

Earlier Directly-Related Contracts and Funding:

2.148.1 Propagation Mechanisms of Molten Fuel/Moderator Interaction

It is proposed to join the NSERC in supporting the experimental investigations being carried out at McGill University on the propagation mechanisms of molten fuel/moderator interaction. The proposed program comprises experiments in which steam explosion will be triggered in arrays of molten tin drops immersed in water, and the subsequent propagation mechanism will be observed with high speed photography and fast response pressure instrumentation.

Overall knowledge of the controlling mechanisms for steam explosions resulting from the mixing of hot and cold liquids is poor at present. The proposed low-cost program would permit AECB staff to maintain awareness of current technical and scientific developments.

This program would provide useful background information to assist AECB staff in understanding this complex phenomenon and would assist in the resolution of relevant safety issues.

Proponent	SSS/SED
Technical Advisor/Evaluator	SED (V.Q. Tang)
Project Manager	A. Omar
Review Panel	
Contractor	McGill University
Principal Investigator	D. Frost
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$17k	$19k	$0k	$0k	$36k

Earlier Directly-Related Contracts and Funding:

84.1.30	$49000	$0	$0	$49000
2.095.2	$6380	$0	$0	$6380
2.120.1	$34000	$16000	$0	$50000

2.153.1 Computer Codes for Examining Circulation within Containment

It is proposed to acquire the computer code COBRA-NC and convert it to work on one of the AECB in-house computers. The code would be used to examine events such as LOCA and LOECC specifically to determine post-event hydrogen distribution within containment.

In safety analyses for LOCA and LOECC, the concentration of the hydrogen released inside the containment is assumed to be uniform. This assumption needs to be confirmed particularly when cooling fans are not credited. Hydrogen concentration distribution within the containment is an important parameter in taking the decision as to when the ignitors should be initiated.

The outcome of this study would be used in evaluating the consequences of a hydrogen burn, and the appropriateness of the locations of the hydrogen ignitors within the containment.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Khosla)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

2.154.2 Measurement of RBE for Tritium for Myeloid Leukemia

It is proposed to continue funding the laboratory experiment to measure the Relative Biological Effectiveness for tritium beta rays for the induction of myeloid leukemia in mice.

The study was proposed because of the concern as to whether or not a given dose of tritium beta rays is equally as effective as the same dose of 200 kVp X-rays, delivered at the same dose rates, for the induction of myeloid leukemia. A feasibility study completed in FY 84/85 has recommended a full-scale multi-year study on CBA/H mice. Note: Due to the breakdown of the 300 kVcp generator, the study is being performed using a suitably filtered 150 kVcp X-ray beam. This is not anticipated to undermine the validity of the results.

It is anticipated that the results of the study will improve the estimate of the quality factor (QF) for tritium beta rays. (This is a joint study with AECL, Ontario Hydro, Hydro Quebec and NBEPC. The total cost of the study is $1,221.7K; the share breakdown is: AECB $335K, AECL $574.3K, Utility Group $312.4K.)

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	E. Rabin
Review Panel	6
Contractor	Atomic Energy of Canada Ltd. - CRNL
Principal Investigator	D.K. Myers
Category	1*

Past	88/89	89/90	90/91	Future	Total
$158k	$80k	$105k	$0k	$0k	$343k

Earlier Directly-Related Contracts and Funding:

2.155.1 Maintenance: Means and Methods

It is proposed to conduct a critical survey of the literature dealing with the methods, procedures and techniques of maintenance used to ensure the adequacy and to determine the status of equipment performance while on-line. The study would cover nuclear and non-nuclear industries. The proposed survey would include detailed description of various maintenance techniques such as preventive, corrective and reliability-centred maintenance.

According to independent assessments by the utilities and the AECB, inadequate maintenance is the primary cause of numerous significant events. A project that would review and possibly suggest improvements to the current maintenance programs is proposed. Such a project would address, inter alia, the following aspects: a) methodology used in the various types of maintenance; b) the frequency of maintenance performed on equipment; c) adequacy of maintenance procedures - conformance with manufacturers' recommendations/requirements; and d) qualifications and training of maintenance personnel. In a first phase, the part of the review dealing with the nuclear industry will focus on maintenance programs/practices in countries other than Canada.

The results would be used to affect improvements through the enhancement of standards for quality assurance programs in facility operations.

Proponent	SSS, CQAD, PRDB
Technical Advisor/Evaluator	CQAD (D. Vincent), PRDB (R. Ferch)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$20k	$0k	$0k	$20k

Earlier Directly-Related Contracts and Funding:

2.157.1 Consequences of Severe Accidents in Canadian Power Reactors

It is proposed to perform a study of the consequences of postulated severe accidents at Canadian nuclear generating stations (NGS). "Severe accidents" are accidents which are more severe than the so-called "design-basis accidents" which currently form the basis for AECB licensing of nuclear power reactors. The first phase of the study would be based on the Pickering A NGS. The severe accidents to be studied initially would include the current menu of single and dual failures not involving containment impairment, combined with various modes of containment failure, including modes not currently considered in licensing. Where data are supported by some degree of validation, analyses would be done on a "best estimate" basis; that is, by selecting the best estimate of, or most likely values for, parameters influencing the consequences, or by selecting a range of values for parameters which are known to vary considerably, e.g., weather conditions. The study would include both the short term and long term consequnces and local, regional and global impacts. Subsequent phases of the study would include similar considerations at other Canadian NGS of different designs and locations.

The study is proposed because of increased public skepticism about the industry claims regarding the low probability of severe accidents in the wake of the Three Mile Island and Chernobyl accidents. On the other hand experience from the Three Mile Island accident, which is probably more relevant to Canadian reactors than the Chernobyl accident, demonstrated that existing safety analyses may be unduly pessimistic in predicting consequences.

The information obtained from this study would be useful to the AECB and to governments for developing advice or making decisions regarding nuclear insurance or siting policy for large power reactors.

Proponent	ACNS
Technical Advisor/Evaluator	DRR (Z. Domaratzki)
Project Manager	A. Omar
Review Panel	14
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$20k	$100k	$0k	$0k	$120k

Earlier Directly-Related Contracts and Funding:

2.158.1 Evaluation of Functional Specification Review Techniques

It is proposed to apply a descriptive language or other automated technique to evaluate a software functional requirement specification, such as for the trip computer software for Shutdown System 1 of the Darlington Nuclear Generating Station. A possible technique might be to transform the functional specification document into a database of rules via a descriptive programming language such as LISP or Prolog. This database would be analyzed for such characteristics as precision, lack of ambiguity, consistency and completeness.

The majority of software faults are due to deficiencies in the functional specification. Currently the checking of functional specification currently is based primarily on informal inspection. However, the program design, coding, and testing all rely on a thorough functional specification. The Darlington Shutdown Systems rely completely on software so it is essential that the integrity of the trip computer functional specifications be established.

This study will introduce AECB staff to formal testing or checking techniques for reviewing software functional requirement specifications. The resulting representation of the SDS-1 trip computer functional specification may also be used to model the behaviour of the system for reactor safety analysis and to assess the effectiveness of licensee test data sets.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Kendall, C. Downie)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

2.162.1 Childhood Leukemia around Canadian Nuclear Facilities

It is proposed to fund the ongoing epidemiological study of leukemia among children born in the vicinity of Canadian nuclear facilities. In this phase of the study, the incidence of leukemia among children (0 to 4 years) born within a radius of about 20 kilometres of the nuclear facilities at Pickering, Chalk River and Rolphton, and Port Hope, Ontario, will be compared with the corresponding incidence of childhood leukemia among suitably selected control groups.

This project is proposed because of some concern in the literature that children born in the vicinity of nuclear facilities might show an elevated incidence of leukemia (Brit. Med. Journal 295, 822-827, 1987). It is therefore important to find out whether such concern is applicable to the children born in the vicinity of Canadian nuclear facilities.

It is anticipated that the results of this study will clarify the concern as to whether or not there exists any clustering of childhood leukemia in the vicinity of these nuclear facilities. If the results of the Phase I study are inconclusive, then the second phase of the study (Phase II) will be initiated in which the investigation of childhood leukemia will be extended to children up to the age of 14 years. If there is an indication of the existence of any statistically significant clustering, then a detailed study (Phase III) at these and other nuclear facilities in Canada will be proposed to examine the influence of radiation doses and any other factors, such as exposure to chemicals present in the environment, on the incidence of childhood leukemia.

Proponent	RPD, ACRP
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	2
Contractor	Ontario Cancer Treatment and Res Foundat
Principal Investigator	A. Clarke
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$58k	$40k	$2k	$0k	$100k

Earlier Directly-Related Contracts and Funding:

2.164.2 Review of Training Materials

A project is proposed which would review reactor operator training materials. The review would identify and describe any deficiencies in the materials which are detrimental to their effectiveness as teaching or learning aids.

In recent time, AECB staff have found a pervasive lack of quality in training texts prepared by some licensees. These deficiencies include technical errors, lack in logical progression, and generally questionable 'teachability'. AECB staff have expressed strong concerns to the licensees and have found a surprising level of complacency. It appears that a training 'culture' has developed which is insensitive to what AECB staff believe is a vital need in training.

The results of the contract would be used in the on-going discussions with licensees on the effectiveness of their reactor operator training programs.

Proponent	OCRFD
Technical Advisor/Evaluator	OCRFD (F. Davediuk)
Project Manager	D.J. Martin
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

2.164.1	$0	$3000	$0			$3000

2.165.1 Studies of Stability and Related Issues for Small Reactors

A project is proposed which survey the information available on instabilities in low-pressure, low-flow, natural circulation reactors. The project would focus on tools and techniques which would assist studies of potential instability regimes of these reactors.

There are indications that instability regimes exist for low-pressure natural circulation reactors. Most of the existing studies on instabilities in reactors are for high-pressure (BWR and PWR) designs. The AECB wishes to analyze the situation for proposed low-pressure designs under consideration by licensees. As a first step, the existing available information must be assessed.

The results of the project would assist AECB staff in reviewing safety documentation submitted to support licensing of small or research reactors. It would also provide generic information of importance for several other small reactor proposals, including the conceptual 10 MW heating reactor.

Proponent	OCRFD
Technical Advisor/Evaluator	OCRFD (P. French), SED (A.M.M. Aly)
Project Manager	D.J. Martin
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

2.166.1 Ballooning of Heavily Hydrided Pressure Tubes (I)

It is proposed to sponsor a project to perform creep tests and/or ballooning tests on heavily deuterided specimens cut from NPD pressure tubes. To be most useful, such tests would have to be performed at temperatures or temperature rates representative of a fuel channel in which coolant stagnation has occurred (25-30 K/s).

It has been predicted that certain failures in reactor cooling systems could lead to coolant stagnation in fuel channels and to the ballooning and eventual rupture of pressure tubes. Such predictions must now be based on the properties of new pressure tube material which are ductile and low in dissolved deuterium. Irradiated and deuterided material is known to be more brittle and may experience a greater change in creep resistance.

The results of this project could lead to an improved ability to predict the strain at failure of rapidly creeping pressure tubes by confirming or developing hypotheses about the effects of irradiation and deuteriding of zirconium alloys. This would permit AECB staff to better assess predictions of pressure tube behaviour in accident situations.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (B. Jarman)
Project Manager	J. Pachner
Review Panel	15
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$250k	$0k	$0k	$250k

Earlier Directly-Related Contracts and Funding:

2.168.1 Aging of CANDU Heat Transport Pressure Boundary Components

It is proposed to conduct a review of operating experience in the long-term degradation of carbon steel piping and other pressure boundary components under service conditions similar to those found in CANDU primary heat transport (PHT) systems.

The recent catastrophic failure of a secondary side line at a nuclear power plant (NPP) in the United States drew attention to significant corrosion and erosion that has been occurring undetected in NPP secondary system piping. As a result, many NPP licensees now either have or are about to implement programs for examining and monitoring the condition of secondary system piping. Relatively little has been done thus far for PHT pressure boundary components because of the belief that their design and operating conditions make it unlikely that significant degradation will occur during the typical plant design life of 30 to 40 years. The aim of the proposed study is to confirm that even for the long term there is a very low probability of significant degradation of pressure boundary components in CANDU PHT systems.

Project results would aid in the formulation of an AECB staff position on measures that need to be taken to assure the long-term fitness-for-service of CANDU PHT pressure boundary components.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (J.K. Periera)
Project Manager	J. Pachner
Review Panel	15
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$40k	$0k	$0k	$40k

Earlier Directly-Related Contracts and Funding:

2.169.1 Reliability-Centred Maintenance Review of Safety Systems

It is proposed to conduct a review of selected Pickering A safety-related systems using the reliability-centred maintenance (RCM) methodology. The proposed work would include a review of system design, and operation and maintenance histories to determine the functionally significant items of the systems and to identify the dominant failure modes, causes and effects. RCM decision logic would be used to find the most effective preventive maintenance (PM) activities. These would then be compared with the existing PM program. It is proposed to review the moderator system in the first phase of the review.

Effective PM programs are essential for maintaining adequate operational safety of nuclear power plants. To ensure effectiveness of the PM programs, they should be periodically reviewed and modified on the basis of operating experience. RCM methodology, developed in the aerospace industry originally for the Boeing 747 aircraft, is a widely accepted and effective tool for large engineering systems. Pickering A is proposed for the RCM review as a lead nuclear plant in Canada. This selection is based on the aerospace industry concept of a fleet leader (an aircraft with the greatest service) which is expected to exhibit the highest degree of degradation. The moderator system has been chosen for this review because it is one of the essential mitigating systems for loss-of-coolant accidents.

Results of the proposed work would provide an insight on the effectiveness of the current PM program, identify its weaknesses and recommend improvements. The project would also provide a demonstration of the feasibility of RCM methodology at Canadian nuclear power plants.

Proponent	SSS, PRDA
Technical Advisor/Evaluator	PRDA (J. Tong)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$85k	$0k	$0k	$85k

Earlier Directly-Related Contracts and Funding:

2.170.1 Reliability of Electrical Motors under Accident Conditions

It is proposed to determine the functional capability of naturally aged safety system electrical motor windings under accident and post-accident conditions, and to correlate the findings with the results of various non-destructive diagnostic measurements performed before and after the accident exposure. A heavy water coolant recovery motor was removed from NPD NGS containment area for this purpose. The proposed work would involve collection of data on the nature of the service environment, and laboratory tests and assessments at Ontario Hydro Research Division (OHRD). This would be a joint project with OHRD with a total cost of approximately $100,000.

Reliability of safety system electrical motors under expected accident and post-accident conditions is essential for the effective mitigation of accidents, should they occur. Present non-destructive diagnostic techniques have a limited capability for detecting the degradation of motor windings before failure and for predicting the remaining life for normal operating conditions. (Research work at OHRD sponsored by EPRI is addressing this limitation.) These diagnostic techniques are not able, as yet, to predict the performance of motor windings under accident and post-accident conditions.

The proposed work would enhance the development of effective condition monitoring techniques capable of detecting degradation before failure and of predicting remaining life under all anticipated service conditions, including accident and post-accident conditions. The results would improve the capability to assess findings of diagnostic motor tests and would thus contribute to maintaining operational readiness of NPP safety systems.

Proponent	SSS, SED
Technical Advisor/Evaluator	SED (T. Leung)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

2.171.1 Portable Information Processing for Quality Assurance Audits

It is proposed to carry out a trial of a portable support system based on a laptop personal computer and standard off-the-shelf software to perform information processing during AECB quality assurance audits at Canadian nuclear generating stations. The contractor would review the user requirements, recommend appropriate hardware and software, and supply the recommended system on a rental basis for the duration of the trial.

During AECB quality assurance audits at Canadian nuclear generating stations, interim findings must be prepared under very tight schedules with limited staff. The audit process is very systematic hence it may be feasible to use existing laptop personal computer technology to alleviate the clerical workload and to improve the productivity of an audit team. The laptop system would also offer the possibility of integrating the preparation, field and corrective phases from an information processing viewpoint allowing efficient generation of reports and enabling more effective follow-up monitoring.

The results of the trial would be used to decide whether it would be worthwhile to use portable information processing systems more extensively in quality assurance audits at nuclear generating stations.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (M. Massicotte, D. Scrimger)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$10k	$0k	$0k	$10k

Earlier Directly-Related Contracts and Funding:

2.172.1 Computer-Based Safety Interlocks for Research Accelerators

It is proposed to carry out a study focused on the safety requirements for computer-based radiation interlock systems at research accelerator facilities.

Nuclear research requires accelerators that can produce particle beams of high energy and power leading to complex facilities that cannot be operated without intensive use of computers in the control and safety interlock systems. As a result, research accelerator facilities in Canada such as the Linear Accelerator Laboratory and TRIUMF are beginning to make significant use of computers to monitor or control their radiation interlock systems. Real-time computing systems are susceptible to unsafe failures due to undetected software faults and unforeseen combinations of hardware/software failures. Regulatory guides are urgently required in this area for accelerators but the AECB does not have sufficient in-house resources to collate the necessary supporting information within the time frame imposed by the implementation of the new licence format and the rapid progress of the TRIUMF KAON-factor project.

The results of this work will assist AECB staff in preparing a regulatory basis and recommendations for regulatory actions concerning computer-based radiation interlock systems for research accelerators.

Proponent	OCRFD
Technical Advisor/Evaluator	OCRFD (A. Guilbaud, M. James)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$80k	$0k	$0k	$80k

Earlier Directly-Related Contracts and Funding:

2.174.1 Hydrogen Absorption-Desorption at Metal Surfaces

It is proposed to conduct a study to examine the phenomenon of hydrogen absorption on, and desorption from, zirconium wire surfaces. The study would also include performing and analyzing the results of a series of small-scale experiments on Zr/Nb material.

In experiments performed on hydrided zirconium wire, hydrogen was observed to de-gas from the surface of the wire when the specimen was reheated. In addition a significant amount of material was found to have been removed from the surface, pits had formed and the surface appeared granular. If this phenomenon is occurring in pressure tubes, it could explain why the expected relationship between hydriding and thick oxide layers is not evident and may also explain why delayed hydride cracking seems to be related to transient behaviour rather than to time at power. A change in our understanding of the hydriding process may influence plant operation, particularly in regard to delayed hydride cracking avoidance manoeuvres, and may change the end-of-life and fitness-for-service criteria.

The results of the study would be of assistance in determining whether the phenomenon of absorption-desorption of hydrogen on and from Zr-Nb surfaces could have any implications for the behaviour of CANDU pressure tubes.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (B. Jarman)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$55k	$20k	$0k	$75k

Earlier Directly-Related Contracts and Funding:

2.175.1 Pump Cavitation and Piping Vibration (I)

It is proposed to conduct a multi-phase study to investigate pump cavitation and piping vibration, and their interrelationship. Phase I would review Ontario Hydro pump stability piping analyses, and perform a literature search on large amplitude piping vibrations. Also in Phase I the contractor would be asked to design a simplified small diameter pipe loop. This should take into account the predicted PHT piping vibration and main coolant pump two-phase flow characteristics. Phase II of the study would be to build and commission a test loop. The instrumentation should be sufficient to define the displacement of the test section, flow characteristics of the fluid, and the overall energy balance. The test results would be analyzed and compared with the findings of Phase I.

Pump cavitation under voided conditions can cause severe pipe vibration. Calculations, based on forces measured directly on reactor main coolant pumps, predict that the vibration can be of such magnitude that failure of the pump supports or piping can occur. These calculations are complex and include numerous assumptions so that it is difficult to assess whether they are conservative or not.

The results of this study would be used by AECB staff to acquire information on the characteristics of cavitation-induced piping vibration and its relationship to the energy input to the pump. This information would then be used in the evaluation of piping stability analyses presented by licensees.

Proponent	CQAD
Technical Advisor/Evaluator	CQAD (B. Jarman)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$35k	$150k	$50k	$235k

Earlier Directly-Related Contracts and Funding:

2.176.1 Software Functional Requirement Specification Techniques

It is proposed to identify and evaluate the suitability of techniques for the definition of software functional requirements for safety critical computer-based systems. This work would provide AECB staff with the latest information available concerning the preparation of software functional specification for safety critical applications of programmable controllers and microcomputers in nuclear generating stations.

The software functional requirement specification is the cornerstone upon which a software project is built. It is used in every phase of the project; structural design, coding, debugging, integration testing, and validation testing. Omissions or lack of clarity can result in software that does not function as desired. Studies have shown that this is the most common source of software failures.

The results of this study would be used to assess the effectiveness of methods used by licensees to specify safety critical software functional specifications for nuclear generating stations.

Proponent	SED
Technical Advisor/Evaluator	SED (J. Kendall)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

2.177.1 Fuel Channel Refilling: Data Analysis

It is proposed to undertake a study in which selected data from previous non-AECB Cold Water Injection Tests (CWIT) and RD-14 experiments would be analyzed. The aim would be to identify the parameters and factors that control and characterize the processes of refilling and rewetting a fuel channel under loss-of-coolant conditions. The study would also include a comparison of the experimental data and corresponding CATHENA code predictions.

There exists a large body of data relating to the process of refilling a "hot" fuel channel with "cold" emergency water; and only a fraction of these data have been analyzed. AECB staff have not been able to review either the analyses conducted so far or the raw data due to lack of resources.

Review of the data produced in cold water injection tests would better the understanding of the phenomena related to the refilling and rewetting of a CANDU fuel channel following a loss-of-coolant event. In addition, CATHENA comparison with the data would provide information on the capabilities and limitations of advanced two-fluid thermodynamic codes, and could be used to identify a set of standard problems against which licensee codes could be checked. The latter benefit is particularly important to AECB staff because of the anticipated increase in the role of two-fluid codes in licensing submissions.

Proponent	SED
Technical Advisor/Evaluator	SED (V.Q. Tang)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$45k	$0k	$0k	$45k

Earlier Directly-Related Contracts and Funding:

2.178.1 Critical Heat Flux Measurements in a Simulated Fuel Bundle

It is proposed to enter into a cost-sharing experimental program with AECL-CRNL in which an old 37-element cosine simulated fuel bundle would be rebuilt and its instrumentation repaired; the bundle would then be used to conduct a new series of critical heat flux (CHF) tests.

Several controversial issues are associated with the data obtained using this cosine bundle in 1982 and 1983. For example, there exists a10% difference between the two data bases, and no allowance in determining the CHF values was made for the lack of comprehensive instrumentation coverage. These concerns were reinforced by a recent study done for the AECB (2.126.1) in which it was recommended that a new data base be obtained.

The results of the proposed test series would be used to: a) complement the available data base; b) reconcile the 10% difference between the 1982 and 1983 data bases; and c) assess the CHF correlation being used at present in the neutron overpower protection analysis for several CANDU stations.

Proponent	SED
Technical Advisor/Evaluator	SED (A.M.M. Aly)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$75k	$200k	$125k	$400k

Earlier Directly-Related Contracts and Funding:

2.179.1 Performance of Steam Generator Emergency Water Injection

It is proposed to conduct an experimental study in which a section of the secondary side of a steam generator would be built and used to investigate phenomena associated with the emergency injection of water into the steam generator secondary side under accident conditions. The test section would be as close as possible in design to the actual geometry of the steam generators used in the Darlington NGS.

Licensing submissions addressing the effectiveness of the steam generator emergency cooling injection system have treated some of the crucial parameters as uncoupled. AECB staff believe that combined effects such as spray header water distribution, hot wall, and steam flow behaviour would dictate the overall performance of the steam generator emergency cooling system.

The results of this study should provide insight on particular aspects of cold water injection into the steam generator secondary side, and would be used to assess the validity of licensee submissions on this topic.

Proponent	SED
Technical Advisor/Evaluator	SED (Q.S. Truong, J. Khosla)
Project Manager	A. Omar
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$65k	$30k	$0k	$95k

Earlier Directly-Related Contracts and Funding:

2.180.1 Testing Methods for Charcoal Filters

It is proposed to conduct a review and assess adequacy of methods used to verify the effectiveness of emergency charcoal filters used in nuclear power plants to remove iodine and organic iodides from ventilation discharge flow, particularly under post-accident conditions. The proposed work would include a survey of research in this area and of standards used in Canada and elsewhere for filter testing.

In the negative pressure containments used in Ontario Hydro's nuclear generating stations, the ultimate engineered barrier to the release of airborne radioactive materials after an accident is the emergency filtered air discharge (EFAD) system. In safety analyses these filters are typically credited with removal efficiencies of 99.9% for organic iodides. There is a need to identify practical and effective testing methods to assure required functional capacity of the filters.

Results of the proposed work would be used to assess the adequacy of the testing methods used in Ontario Hydro stations.

Proponent	PRDB
Technical Advisor/Evaluator	PRDB (R. Ferch), SED (L. Truong), RTD (R. Walker), RPD (S. Ching)
Project Manager	J. Pachner
Review Panel	
Contractor	
Principal Investigator	
Category	2

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$35k	$0k	$0k	$35k

Earlier Directly-Related Contracts and Funding:

2.181.1 A Computer Program for Assisting Emergency Response Decisions

It is proposed to fund a contract to have a user-friendly computer program written and set up on the AECB computer system to be used for simulation of nuclear emergency response in relation to public radiation exposure control.

Currently, AECB does not possess any capability in nuclear emergency response. Experience from the recent involvement with Nuclear Emergency Preparedness Exercise at Bruce A suggested that problems still exist with OH's ERP and there are not enough timely resources for helping with the decision-making for public radiation exposure control.

The results of the project, a computer program, will used for simulation and independent assessment of nuclear plant and surrounding conditions following a potulated accident as an input to response decisions.

Proponent	SED
Technical Advisor/Evaluator	SED (L. Truong)
Project Manager	D.J. Martin
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$40k	$0k	$0k	$40k

Earlier Directly-Related Contracts and Funding:

2.182.1 Human Performance Monitoring in Nuclear Power Plants

It is proposed to conduct a review of methods used to monitor and evaluate human performance. The proposed work would include a survey of industries with an impact on public safety, including (but not limited to) civil aviation, chemical process industries, and nuclear industries (outside Canada). The project would amass information about assessment methods used to survey and evaluate human performance.

The AECB currently licenses reactor first operators and shift supervisors by means of a formal examination process. However, safe reactor operation depends on the activities of many other individuals, ranging from maintenance staff to engineers in the technical unit. The AECB is therefore considering the addition of an activity to its reactor inspection program. This activity would seek to confirm on a routine basis that individuals working at a reactor site have received training appropriate to their function, and that they are applying that training completely in their work.

The proposed work would provide information about human performance monitoring and assessment methods that could be used by the AECB at nuclear power reactor sites.

Proponent	PRDA
Technical Advisor/Evaluator	PRDA (I. Lee), SED (L. Innes)
Project Manager	D.J. Martin
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

3.101.2 Demonstration of the Feasibility of Directly Dating Quartz (2)

It is proposed to obtain samples of rock, the ages of which lie for the most part within the range of from about 400 million years to 1,000 million years, and date them using the electron spin resonance dating technique developed in Phase 1.

This study is proposed in order to establish conclusively that a linear relationship exists between the strength of the ESR signal and the age of the quartz. This apparent relationship was discovered in the previous study by evaluating samples in the age ranges of from 100 thousand to 400 million years and from 1 billion to 1.4 billion years. However, the 600 million year data gap between those two groupings has to be filled in order to confirm or deny the relationship.

It is anticipated that the results of this study, if they establish that the linear relationship exists, will eventually be useful for determining the age of last movements along faults. This will, in turn, provide a means for determining whether or not an area is tectonically stable.

Proponent	SSS
Technical Advisor/Evaluator	SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	16
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

3.101.1	$50000	$0	$0			$50000

3.103.1 Absorbed Fraction of Ingested Uranium in Humans

It is proposed to determine the absorbed fraction of ingested dietary uranium in humans, including those persons living in uranium mining communities, by measuring the content of uranium in their diet and in their fecal and urinary excretions.

The currently used annual limit on intake (ALI) for uranium, by ingestion, is derived using a value of 0.05 for the absorbed fraction of ingested uranium. This fraction is known to have a number of uncertainties, and more work should be done to improve its accuracy.

The results of the study are expected to improve the value for the absorbed fraction and hence the estimate of the ALI for uranium.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$60k	$20k	$0k	$80k

Earlier Directly-Related Contracts and Funding:

3. OTHER FUEL CYCLE FACILITIES, GENERAL

3.106.3 Transfer of Radionuclides to Human Milk - Phase 3 Pilot Study

It is proposed to conduct a small-scale sampling and analytical program to determine the concentration factors for certain radionuclides in the uranium and thorium decay chains in the pathway from food to human milk. It is also proposed to estimate radiation dose to infants feeding on mothers' milk. In a recently completed feasibility study (INFO 0192-2) adequate techniques for determining the very low levels of these radionuclides found in human milk samples were developed. A detailed plan for a full-scale sampling program was also recommended in the report.

A literature survey conducted for the AECB (INFO 0192) has shown that little information exists on the transfer of radionuclides via the human milk pathway. As part of an ongoing review, the AECB has therefore decided to conduct research to determine whether this is a significant pathway in contributing radiation dose to breast-fed infants.

It is anticipated that the results of the study will enable the AECB to determine the importance of human milk as a component in radionuclide transfer and, consequently, its significance in the derivation of release limits for nuclear facilities, such as uranium mines and mills.

Proponent	RPD
Technical Advisor/Evaluator	RPD (C. Letourneau)
Project Manager	R. Avadhanula
Review Panel	11
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$20k	$70k	$15k	$0k	$105k

Earlier Directly-Related Contracts and Funding:

84.4.17	$30000	$0	$0	$30000
86.4.9	$40000	$0	$0	$40000

3.111.1 Evaluation of Data and Models on Uranium Metabolism - Europe

It is proposed to continue to fund the compilation of currently known data regarding the intake, transfer (among organs), retention, and excretion rates of uranium in uranium workers, with a view to testing currently available metabolic and dosimetric models with different data sets, to comparing computed excretion patterns to the observed ones, and to determining which model describes best the known data (or how a selected model should be modified to fit the observed data).

Several models for uranium metabolism exist at present, but none seems to describe realistically uranium transfer, retention, and excretion rates in humans. Since individual doses from occupational uranium intake are generally determined from the interpretation of bioassay data (urinalysis), it is critical that the AECB Radiation Protection Division identify and acquire a reliable tool for dose calculation in the case of exposure to uranium compounds.

It is anticipated that the study will assist in identifying and in providing the AECB staff with the state-of-the-art metabolic and dosimetric model for uranium intake.

Proponent	RPD
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	P. Duport
Review Panel	4
Contractor	Centre d'Études Nucléaires de Fontenay-aux-Roses
Principal Investigator	P.G. Beau
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$15k	$21k	$4k	$0k	$40k

Earlier Directly-Related Contracts and Funding:

3.111.2 Evaluation of Data and Models on Uranium Metabolism - North America

It is proposed to continue to fund the compilation of currently known data regarding the intake, transfer (among organs), retention, and excretion rates of uranium in uranium workers, with a view to testing currently available metabolic and dosimetric models with different data sets, to comparing computed excretion patterns to the observed ones, and to determining which model describes best the known data (or how a selected model should be modified to fit the observed data).

Several models for uranium metabolism exist at present, but none seems to describe realistically uranium transfer, retention, and excretion rates in humans. Since individual doses from occupational uranium intake are generally determined from the interpretation of bioassay data (urinalysis), it is critical that the AECB Radiation Protection Division identify and acquire a reliable tool for dose calculation in the case of exposure to uranium compounds.

It is anticipated that the study will assist in identifying and in providing the AECB staff with the state-of-the-art metabolic and dosimetric models for uranium intake.

Proponent	RPD
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	P. Duport
Review Panel	4
Contractor	Oak Ridge National Laboratory (ORNL)
Principal Investigator	K. Eckerman
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$5k	$40k	$35k	$0k	$80k

Earlier Directly-Related Contracts and Funding:

3.115.2 Neutron Dosimeters and Survey Meters in Accelerators (II)

It is proposed to fund a project that, by means of laboratory and field tests, will provide information on the neutron spectra at occupied areas in AECB licensed facilities and on neutron dosimeter/survey meter suitability, where such information does not exist. In addition side-by-side testing of the most suitable neutron detectors for each type of facility and use listed in Phase I (3.115.1) will be carried out either at the facilities/workplaces or in the laboratory under conditions of exposure that simulate working conditions at the facilities/workplaces.

This project is proposed to augment the information obtained in Phase I. Performance of this project is therefore conditional upon the findings of Phase I.

It is anticipated that the results arising from an examination of the neutron spectra together with the evaluation of neutron dosimeters and survey meters will result in an optimized use of such equipment.

Proponent	RPD
Technical Advisor/Evaluator	RPD (G.S. Poirier)
Project Manager	E. Rabin
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$20k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

3.115.1	$0	$15000	$0			$15000

3.121.1 BIOMOVS - Intercomparison of Environmental Assessment

It is proposed to collaborate with Atomic Energy of Canada Ltd. (AECL) in supporting Canadian participation in an international intercomparison of environmental assessment models and their predictions, a program called BIOMOVS, which is organized by the Swedish International Institute of Radiation Protection (NIRP) in cooperation with the Nordic Liaison Committee for Atomic Energy. It is also proposed that Canadian experts participate in the exchange of ideas, Canadian experience and information to improve the confidence with which the environmental behaviour of radionuclides in the biosphere can be assessed quantitatively.

Environmental and pathways analysis models are used by AECB licensees to derive release limits for nuclear facilities and to predict doses to members of the public from waste management practices. The assessment of the possible consequences of the release of radionuclides often depends entirely on the predictions of mathematical models. Because the model predictions are subject to uncertainty, their reliability must be evaluated. It is well recognized that the evaluation of the reliability of model predictions requires a variety of tests involving comparisons of model predictions against independent data sets over a range of environmental conditions and intercomparison of the predictions made by different models. Participants in the BIOMOVS project plan to test the accuracy of the predictions of environmental assessment models for selected contaminants and exposure scenarios to explain differences in model predictions due to structural deficiencies, invalid assumptions, and/or differences in selected input data, and to recommend priorities for future research to improve the accuracy of model predictions.

Involvement of Canadian experts in this intercomparison is important in ensuring credibility to modelling activities in Canada and regulatory decisions based on such modelling. A collaborative involvement of both CRNL staff and AECB staff will help in gaining an appreciation of the validity of terrestrial and aquatic models in general and Canadian models in particular. Improvements in modelling soundness will stem from this. (The estimated costs to AECL and AECB are $205k and $152k respectively.)

Proponent	RPD
Technical Advisor/Evaluator	RPD (C. Letourneau)
Project Manager	R. Avadhanula
Review Panel	
Contractor	Atomic Energy of Canada Ltd. - CRNL
Principal Investigator	P.J. Barry
Category	1*

Past	88/89	89/90	90/91	Future	Total
$5k	$62k	$85k	$0k	$0k	$152k

Earlier Directly-Related Contracts and Funding:

3.121.2 BIOMOVS International Meeting, Ottawa, 1989

AECB contribution to hosting the 1989 BIOMOVS international meeting in Ottawa.

Proponent	
Technical Advisor/Evaluator	
Project Manager	R. Avadhanula
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$5k	$0k	$0k	$5k

Earlier Directly-Related Contracts and Funding:

3.123.1 Influence of Macrophages on Dissolution of Uranium Compounds

It is proposed to study, in the laboratory, the influence of macrophages, oxygen and carbon dioxide on the in vitro dissolution rates of uranium compounds, as a function of the chemical forms and particle sizes of these compounds. (Macrophages are specialized cells whose function is to destroy bacteria and foreign materials that enter an organism.) The results of the in vitro solubility tests will be compared to clearance rates of the same uranium compounds deposited in the tracheal lobe of the respiratory system of sheep.

Experimental data on the biokinetics of uranium in man are not consistently compatible with in vitro solubility rates of the same compounds which are widely used in current dosimetric models. Recent information from laboratories of the French Atomic Energy Commission (Service of Experimental Pathology) indicates that the solubility rate of uranium compounds is significantly enhanced by the presence of macrophages in, and by the addition of oxygen to, simulated lung fluid. The solubility rates observed under these experimental conditions seems to represent more accurately the clearance rates observed in man. The solubility rate of radioactive material is an important parameter of metabolic and dosimetric models, and it is necessary that AECB staff know, and use, the most realistic and accurate parameters in these models, whether for determining regulatory exposure limits or for deriving bioassay guidelines for accidental or routine radiation exposures. The proposed study would be designed on the basis of the procedures developed and tested by the French Atomic Energy Commission and on the use of sheep as an experimental animal. It has been shown that the respiratory tract of sheep, with its tracheal lobe that branches directly from the trachea, lends itself to localized deposition of test materials without impairing significantly respiratory functions. However, these procedures would be used in parallel with procedures developed in previous AECB studies, with a view to correlating data of past and future solubility tests.

It is anticipated that the results of the study will provide the AECB with realistic solubility parameters to be used for the determination of bioassay guidelines, and for exposure and dose calculations. It is also anticipated that the results will be used to develop a laboratory procedure to determine, accurately and economically, solubility rates and lung clearance rates of uranium compounds.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	P. Duport
Review Panel	5
Contractor	University of Sherbrooke
Principal Investigator	R. Bégin
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$10k	$60k	$60k	$10k	$140k

Earlier Directly-Related Contracts and Funding:

3.124.1 Assessment of Errors in Airflow Measuring Instruments (U Mines)

It is proposed to determine theoretically and experimentally (in the laboratory) the errors and uncertainties associated with the the measurement of airflow rate in air monitoring instruments with a view to evaluating the contributions of these errors to the overall uncertainties attached to the measurements of airborne radioactivity.

Current methods used to determine the concentration of airborne radioactive materials are based on the use of fixed or portable instruments that draw a volume of air through a filter. The air concentration of radioactive material is calculated from the activity collected on the filter and from the total volume of air drawn through the filter. Since sampling apparatus is generally not equipped with a time integrating meter, the volume of air sampled is derived from a short-time airflow rate measurement. Airflow rates are measured with a variety of instruments that are based on different principles (bubble tube, rotameter, mass flow meter, wet test meter, hot-wire flow meter) and respond differently to changes in pressure and temperature. Sometimes, sampling equipment is tested in the laboratory, under pressure and temperature conditions different from those encountered in the field. Some pumps produce a pulsated flow that may affect the response of certain types of flow meters. All the above affect the reliability and comparability of airflow measurements which are made to calibrate sampling systems. Although the determination of uncertainties and errors in radiation counting have been thoroughly documented, the contribution of errors and uncertainties attached to airflow measurements has never been studied in the context of air monitoring for radiation protection purposes. The knowledge of these errors is necessary to evaluate the accuracy and reliablity of "air quality" data collected in mines, mills, and other facilities in which airborne radioactivity is a hazard.

It is anticipated that the study will identify the sources of error and the magnitude of the uncertainties attached to airflow rate measurements that are used together with radiation counting to measure the activity concentration of radionuclides in air. It will therefore allow AECB staff to compare and assess the reliability and accuracy of monitoring data provided to the AECB, by its licensees, as evidence of compliance with the relevant licences and regulations.

Proponent	UMD, HES
Technical Advisor/Evaluator	UMD (K.Bundy)
Project Manager	P. Dupont
Review Panel	
Contractor	CANMET Elliot Lake Laboratory
Principal Investigator	J. Bigu
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$15k	$25k	$0k	$0k	$40k

Earlier Directly-Related Contracts and Funding:

3.125.1 Study of Chemical Toxicity of Uranium Hexafluoride

It is proposed to investigate the chemically toxic effects in humans, from accidental acute releases of uranium hexafluoride in uranium conversion plants.

The chemical toxicity of uranium and fluorine are known individually. However, during an accidental release of uranium hexafluoride in a conversion plant, it is probable that an acute uptake of uranium by workers will be associated with an acute uptake of the fluoride. The tests to determine if a worker may have suffered damage to his organs are based primarily on the results of uranium excretion patterns and kidney function assessments. This work is proposed because it appears that there is insufficient information available on the toxic effects due to the combination of uranium and fluorine in the compound uranium hexafluoride.

It is anticipated that the proposed research will provide information on the health effects of uranium hexafluoride on humans from accidental acute releases in conversion plants. The gathered information may also be used in the development of action level guidelines concerning the return of acutely-exposed workers to their normal duties. (This project will begin with a literature review; if insufficient information is found, then an animal study will be considered to gather the required information. The costs below reflect the estimated cost for a literature review only.)

Proponent	FWD, RPD
Technical Advisor/Evaluator	FWD (A. Ghosh), RPD (M. Measures)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$20k	$0k	$0k	$20k

Earlier Directly-Related Contracts and Funding:

3.128.1 Fault Investigation - Miramichi Area, N.B.

It is proposed to expose bedrock in an area where lineaments have been identified, a fault is suspected, and seismic events, related to the M5.7 earthquake that occurred in this area in 1982, have been rather precisely located. This project was endorsed in principle by MAGNEC pending a well-defined document.

This study is proposed to see whether the fault or fault zone, movement along which produced the large earthquake and several large aftershocks, shows displacement at the surface.

It is anticipated that the results of this study will be the discovery of a seismogenic source which has a surface expression or some distinct signature. If successful the results will be useful in identifying other faults which may have generated seismic activity prior to the period for which historical records exist.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$35k	$110k	$175k

Earlier Directly-Related Contracts and Funding:

84.4.7	$30000	$0	$0			$30000
84.4.8	$30000	$0	$0			$30000

3.130.2 Neotectonics in Nova Scotia - Phase 2

It is proposed to collect data on deformational structures in unconsolidated sediments and possibly in bedrock in the vicinity of the Aspy Fault along the northern shoreline of Cape Breton Island. This undertaking will be a continuation of that begun, and concluded, along the north shore of the Minas Basin during the summer of 1988. That study exposed some structures which may be related to crustal neotectonics, but which await a more detailed investigation and interpretations.

This study is proposed to continue to provide data on geologically young, and possibly tectonically induced, deformation to a data base being formulated by MAGNEC.

It is anticipated that the results of this study will be helpful in trying to determine if any of the deformational features, seen in the geologically young unconsolidated sediments in the vicinity of the Aspy Fault, are due to crustal tectonics.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$15k	$0k	$0k	$15k

Earlier Directly-Related Contracts and Funding:

3.130.1	$0	$15000	$0			$15000

3.131.2 Neotectonic Investigations in Southern Ontario - Phase 2

It is proposed to continue this project in order to find additional structures and to eventually bring the data together into a coherent report addressing, where possible, the temporal and genetic relationships among the large faults and smaller-scale structures. This proposed project was endorsed by MAGNEC, September 27, 1988.

This study is proposed to increase the knowledge of processes suspected of generating geologically young features as well as to help establish a better understanding of the paleotectonic framework in part of southern Ontario. Work has been underway for the past two years in Prince Edward County, Ontario, designated a test site, within the MAGNEC program, because of the presence of major lineaments and known faults. One of the faults appears to be an extension of the presumably seismically active Clarendon-Linden Fault in New York State. Remotely sensed data, acquired by the Ontario Centre for Remote Sensing, and ground-based structural data, obtained by members of the Ontario Geological Survey, are being accumulated and coordinated. Numerous features have already been identified in the area, heretofore considered to be geologically stable. They comprise pop-ups, open fractures, domes, asymmetric folds and displaced glacial striations along presumed faults, the last feature having apparently been confirmed by small-scale seismic studies. To the north, offset boreholes have been displaced in a reserve fault sense along a gently dipping bedding plane indicating very recent tectonic activity in the vicinity of the Salmon River fault. Moreover, in August, or early September 1988, there was an earthquake of M2.2 on the Salmon River Fault.

The results of this study will add information to the geological component of the MAGNEC program on neotectonics, which is essential to improve the estimate of seismic risk in eastern Canada.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$25k	$75k	$125k

Earlier Directly-Related Contracts and Funding:

	Past	88/89	89/90	90/91	Future	Total
3.131.1	$0	$25000	$0			$25000

3.132.2 Relocation of Seismic Events - Phase 2

It is proposed to continue the work begun last year wherein many earthquakes in southern Ontario and in the West Quebec seismic zone were relocated using two codes: JHD (Joint Hypocenter Determination) and JED (Joint Epicenter Determination). This year efforts will be undertaken predominantly in southern Ontario, though some additional work is anticipated in the West Quebec seismic zone.

This study is proposed to attempt to locate zones, or individual structures, that are in reality seismogenic, but which have, heretofore, not been recognized. This study is one of several to be funded under the auspices of the MAGNEC program.

The results of this study will bear directly on improving seismic hazard estimates because reliable locations of previous seismic events will enable seismologists to do their calculations of seismic wave attenuations from particular locations rather than assuming random sources.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	Mohajer, A.
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$19k	$3k	$0k	$0k	$22k

Earlier Directly-Related Contracts and Funding:

3.104.1	$15000	$0	$0	$15000

3.132.3 Relocation of Seismic Events - Phase 3

It is proposed to continue the work begun two years ago and continued last year, this time concentrating in the western Lake Ontario-Niagara Peninsula area, a propos of the discussion held during the MAGNEC meeting of May 26, 1988. This proposed project was endorsed by MAGNEC, September 27, 1988.

This study is proposed in order to see whether there is a spatial relationship between historic earthquakes and the prominent lineaments in the area of the Niagara Peninsula. Evidence obtained during the two previous phases of this study has shown that many seismic events have been poorly located thus necessitating a re-evaluation of their locations. The results display a more systematic distribution of earthquake epicentres than previously considered and, in at least some cases, now show a spatial relationship to lineaments suggesting that those lineaments may be seismic sources. An excellent example occurs along a lineament extending from the southeast corner of the Baskatong Reservoir.

It is anticipated that the results of this study will bear directly on improving seismic hazard estimates because reliable locations of previous seismic events will enable seismologists to do their calculations of seismic wave attentuations from particular locations rather than assuming random sources.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$35k	$0k	$60k

Earlier Directly-Related Contracts and Funding:

3.104.1	$15000	$0	$0			$15000
3.132.2	$0	$20000	$0			$20000

3.133.1 Carbon-14 in Food and in Excretions

It is proposed to measure the amount of carbon and the specific activity of radioactive carbon (C-14) in the daily intake of food and in the daily excretions of urine and stool obtained from healthy persons.

At present, the daily excretion rate of C-14 due to occupational exposure to radioactive carbon dioxide and to particulates containing C-14 is calculated by measuring the specific activity (C-14 per gram of stable carbon) in an aliquot of urine or stool, and by adjusting for the total stable carbon output in a 24-hour excretory sample. The amount of stable carbon excreted in a daily sample cannot usually be measured, and it is assumed to be equal to that given for Reference Man in ICRP 23. Additionally, an accurate dose estimation due to an uptake of C-14 requires a knowledge of the relative fraction of ingested C-14, which is eventually excreted in both urine and stool samples. There appears to be significant uncertainty in the values for Reference Man given in ICRP 23. It is therefore important to measure these parameters to enable an accurate dose estimation for exposure to C-14 in occupational situations.

The results of this study will improve dose estimates for exposure to C-14 among workers at nuclear facilities and among radioisotope users where C-14 is present.

Proponent	RPD
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	R. Avadhanula
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$10k	$60k	$0k	$0k	$70k

Earlier Directly-Related Contracts and Funding:

3.134.1 RBE from a Microdosimetric Approach

It is proposed to conduct a critical review on the state-of-the-art of the relationship between radiation-matter interactions in cell components and the Relative Biological Effectiveness (RBE), or Quality Factor (Q), of high linear energy transfer radiation with an emphasis on the effect of alpha radiation on the cells of human bronchial epithelium.

In spite of elaborate laboratory experiments and epidemiological studies, risk coefficients for specific types of radiation are determined with uncertainties, at best, of the same magnitude as the variable being determined; in some cases, uncertainties are as large as one order of magnitude. An important parameter in establishing risk coefficients is the RBE of the type of radiation under consideration. Microdosimetry has been a powerful tool in the study of radiation-matter interaction in living cells, and of the changes induced in cell components at the molecular level. The continuous refinement of microdosimetric models has led progressively to a better understanding of radiation effects in the case of radionuclides incorporated in cell components, as well as that of exposure to external radiation. It seems, at present, that convergent efforts in epidemiology, animal experiments and microdosimetry are necessary to determine the RBE and Q values, and therefore the risk, more accurately. At a time when regulatory limits on exposure to radon daughters tend to be revised downward, it is important to understand, as well as possible, the mechanisms that lead from irradiation of lung tissues by alpha particles to malignancies in order to support regulatory decisions.

It is anticipated that a critical review of the state-of-the-art research on the relationship between radiation-matter interaction and biological modification at the nucleus, chromosome, or gene levels in the cell will provide necessary information to AECB staff in this domain and will strengthen the scientific bases upon which regulatory decisions are made.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	P. Dupont
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$20k	$0k	$0k	$20k

Earlier Directly-Related Contracts and Funding:

3.135.1 Measurement of Tritium in Canadian Food Items

It is proposed to conduct analyses and measurements of organically bound tritium (OBT) in Canadian food items, particularly those produced in the vicinity of tritium-emitting facilities, and use these data and analyses to evaluate, critically, recent metabolic models which take into account the transfer and assimilation of organically bound tritium in the estimation of tritium dose.

Tritium is a relatively important radionuclide that is released through atmospheric and aquatic pathways from CANDU nuclear generating stations (NGSs) and from other facilities and licensed activities. These releases are limited by the AECB through the setting of derived release limits which are calculated values based on the dose limit for members of the public. Reports of elevated levels of OBT relative to aqueous tritium (HTO) in food items and in human tissue have raised concern about the effect of such conditions on the validity of dose estimates based on the assumption that all tritium intake is rapidly dispersed throughout the body water and may be monitored adequately by urinalysis. The results of a critical review of the available literature presented in a recent AECB report, "The Assessment of the Significance of Organically-Bound Tritium in Environmental Materials" (INFO 0283), indicate that the specific activity of OBT was higher (in the range of 1 to 4) than that of HTO in most food items studied and that the high ratio of OBT/HTO results in a significanlty higher dose than estimated by the currently used ICRP metabolic model. The report also identified that adequate data on Canadian diet items are lacking and, further, that the meagre data, particularly on meat, as reported in the open literature are uncorroborated.

The results of this project will provide information to AECB staff on the significance of OBT contributing to tritium dose, reliability of metabolic models used in tritium dose estimation and greater confidence in regard to the derived release limits for tritium from Canadian NGSs and from other tritium-emitting facilities. (AECB is expecting to seek joint funding of this project with AECL and the provincial utilities.)

Proponent	RPD
Technical Advisor/Evaluator	RPD (C. Letourneau)
Project Manager	R. Avadhanula
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$55k	$0k	$85k

Earlier Directly-Related Contracts and Funding:

2.156.1	$11000	$0	$0		$11000

3.136.1 Study of Birth Defects around Canadian Nuclear Facilities

It is proposed to conduct a pilot epidemiological study of birth defects among children in the vicinity of Canadian nuclear facilities. In the initial phase of the study, the observed birth defects among children born to mothers resident within about 25 km of the nuclear facilities at Pickering, Chalk River-Rolphton, Port Hope and Elliot Lake will be compared with the expected rates of birth defects in suitably selected control groups.

Studies of the Japanese bomb survivors have revealed that mental retardation is the most significant observed birth defect among children born to mothers who received in utero radiation exposure during the eighth to sixteenth weeks of gestation. In the light of the reported findings of significant excess childhood leukemia around some of the British nuclear fuel reprocessing facilities (Sellafield, Dounreay and Aldermaston), it is important to find out whether there is any cause for concern regarding possible birth defects among children born to mothers resident in the vicinity of nuclear facilities in Canada. (A study of childhood leukemia around some Canadian nuclear facilities is in progress.)

It is anticipated that, if the results of this investigation are positive, a detailed study will be undertaken to examine quantitatively the cause-effect relationship of any such excess in birth defects. If the results are negative, then the findings of the study will be reassuring to the population living near these and other similar facilities in Canada. In any event, the results of this study will further improve our understanding of the dose-effect relationship for birth defects due to exposure to ionizing radiation.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	1
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$30k	$0k	$60k

Earlier Directly-Related Contracts and Funding:

3.139.1 Offset River Terraces in the Charlevoix Seismic Zone

It is proposed to determine the elevations of, and identify layered units and measure bedding attitudes within, terraces on each side of a lineament near Baie St. Paul, Quebec, in the Charlevoix Seismic Zone. Furthermore, it is proposed to attempt to correlate layered units on one side of the lineament with those on the other side. This proposed project was endorsed by MAGNEC, September 27, 1988.

This study is proposed in order to determine whether or not the terrraces are displaced and, if so, by how much. Displacement could indicate the presence of a tectonically active fault, and possibly a seismic source, within the Charlevoix Seismic Zone.

It is anticipated that the results of this study will be useful in identifying an active fault in a known seismic area and thereby establishing a criterion for recognizing potentially active faults in areas of critical structures.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$35k	$125k	$190k

Earlier Directly-Related Contracts and Funding:

3.102.1	$102000	$0	$0	$102000

3.140.1 Convoluted Laminations - A Literature Review

It is proposed to obtain and evaluate information from the literature which deals with convoluted laminations and similar structures in New Brunswick, Nova Scotia and the state of Maine. This project was originally intended to be a field investigation, but MAGNEC believed that valuable, relevant information available in the literature should be assessed before undertaking any field work. Thus the current proposal, to acquire and evaluate existing information, was endorsed by MAGNEC.

This work is proposed because knowledge of the origin of convoluted laminations could have implications for seismic risk assessments. Convoluted laminations are indicators of a sudden shock being applied to water-laden sediments. They are fairly common in the unconsolidated glacio-fluvial sediments of eastern Canada, but their origin is in question. There are classical interpretations related to rapid sedimentation, ice loading or boulders dropping into sediments from freely floating, but progressively melting, ice blocks. However, there is the distinct possibility that they are caused by earthquakes, whether tectonically induced or triggered by sudden shocks attendant upon glacial rebound.

The results of this study will add information to the geological component of the MAGNEC program on neotectonics, which is essential to improve the estimate of seismic risk in eastern Canada.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$20k	$0k	$0k	$20k

Earlier Directly-Related Contracts and Funding:

84.4.16	$41000	$0	$0			$41000

3.141.1 Microseismic Monitoring in the Miramichi Area, N.B.

It is proposed to establish a microseismic network of three seismometers in the Miramichi area. This project has not yet been discussed by MAGNEC. There is a likelihood that some financial support for the project will be provided by the New Brunswick Department of Natural Resources.

This study is proposed because the Miramichi area was subjected to rather large-scale earthquakes in 1982 and is still active today. However, despite the data collected, the active fault (or faults) responsible for the earthquake activity has (have) not been identified. The fact that the area is still active provides an excellent opportunity to try to locate the active fault or faults by establishing a microseismic network in the area. One of the principal targets for monitoring would be the north-northwest trending lineament alluded to in the preceding project description.

It is anticipated that the results of this study will enable determining whether or not there is a spatial relationship between the earthquakes and any of lineaments and thereby aid in identifying the seismic source or sources of the seismic activity.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$40k	$30k	$180k	$250k

Earlier Directly-Related Contracts and Funding:

3.142.1 Stresses to Induce Seismicity in the Miramichi Area

It is proposed to use either existing boreholes or drill new ones in order to inject fluids, induce seismicity, measure the magnitudes and observe the nature of the faults or fractures which produced the earthquakes. The Miramichi area was the site of several moderate earthquakes in 1982 (M5.0-5.7) and is still active, having recently experienced a shock of M3.8. A two-year program was undertaken in 1983-84 to try to locate the surface expression of the fault, movement along which was responsible for the earthquakes. In terms of finding the active fault it was unsuccessful, although valuable information on ambient stress and the rock response to the ambient stress was obtained. This proposed project was endorsed by MAGNEC, September 27, 1988.

This work is proposed to take advantage of previously acquired stress and earthquake data to establish a physical, working model which may aid in identifying seismically active structures in the Miarmichi.

It is anticipated that the results of this study will be useful in identifying the orientations of fracture surfaces likely to be seismogenic as well as the true 3-dimensional movements across those surfaces. This would, in turn, provide further understanding of the nature of seismic activity in one of the more seismically active areas in eastern Canada.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$50k	$0k	$100k

Earlier Directly-Related Contracts and Funding:

3.144.1 Paleoseismicity in the Chicoutimi Area

It is proposed to examine the unconsolidated sediments in the area of Chicoutimi for evidence of seismicity which may have occurred in that area prior to the recording of historical earthquakes (paleoseismicity).

This work is proposed because, according to the federal seismologists, there is no evidence of any large earthquakes having occurred near Chicoutimi. Thus, an earthquake the size of that which rattled eastern Canada, November 25, 1988, (M6.2) and centred just south of Chicoutimi was a surprise. However, a recent examination of sediments near Ferland, Quebec, south-southeast of Chicoutimi, revealed the presence of newly created liquefaction features, such as sand boils in the field and a bedrock fracture filled with sand. Residents in the area confirmed that these features were produced subsequent to the Chicoutimi earthquake. This discovery increases the likelihood of finding paleo-liquefaction features which may provide evidence of past earthquake events.

It is anticipated that the results of this study will be useful in increasing the probability of associating paleo-liquefaction features with seismic events. It will also aid in extending our knowledge of the seismic record in part of eastern Canada further back in time than historic seismic records allow. Should the anticipated results be realized, the AECB will be in a clear, defensible and unequivocal position to require licensees of existing, of applicants of future, nuclear facilities to conduct paleoseismic studies, particularly in areas which are not known to have experienced earthquake activity in historical times.

Proponent	SSS
Technical Advisor/Evaluator	DRR (Z. Domaratzki), SSS (J.L. Wallach)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$50k	$50k	$130k

Earlier Directly-Related Contracts and Funding:

3.145.1 Significance of Urban Pathway in Assessing Public Dose

It is proposed to estimate potential radiation doses under various scenarios for an urban environment by using pathway models selected from the literature. It is also proposed to evaluate whether this pathway is significant in contributing radiation dose to members of the public.

Experience and observations in several countries after the Chernobyl accident suggest that urban pathways should also be consdered along with aquatic and terrestrial pathways in estimating doses arising from nuclear facilities. Radionuclides from plumes are deposited by both wet and dry processes onto exposed surfaces of the urban landscape, such as roads, roofs and walls. The radionuclides most strongly adsorbed by various building materials may remain in place to give rise to external radiation fields or perhaps become airborne again and be redistributed or give rise to internal doses by inhalation. The less strongly adsorbed will move with the wind and drainage water to become redeposited on other retentive surfaces or be carried on through storm sewers to enter rivers and lakes. Increasing labour encroachment around reactor sites in southern Ontario and around other nuclear facilities in Canada makes an assessment of this potential pathway timely.

The results of this study will enable AECB staff to decide whether to ask licensees to estimate doses using urban pathway models in their estimates of derived releases.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Letourneau)
Project Manager	R. Avadhanula
Review Panel	
Contractor	
Principal Investigator	
Category	I

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

3.146.1 Canadian Atmospheric Stability Indicators

It is proposed to fund a study to analyze data collected over several years using statistical techniques and theories of atmospheric turbulence in order to identify relationships between the direct and indirect indicators of atmospheric stability.

In order to calculate the concentrations of radioactivity in the air following a release from a nuclear facility, the stability of the atmosphere must be specified. Since atmospheric turbulence is difficult to measure, this is normally done indirectly through simple indicators that are know to be correlated with direct turbulence estimates. (Temperature gradients as indirect turbulence indicators are frequently used in accident analysis and emergency response programs.) However, these correlations between the direct and indirect indicators were developed in England and the southern U.S. and are inappropriate for the Canadian climate, particularly in the winter when the ground is snow covered.

The results of the project are intended to provide a method to deduce atmospheric stability from simple, routine meteorological measurements for the Canadian climate, and so improve the AECB's confidence in predicted atmospheric radionuclide concentrations following releases from nuclear facilities.

Proponent	SED, RPD, HES
Technical Advisor/Evaluator	SED (L. Truong), RPD (C. Letourneau)
Project Manager	R. Avadhanula
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$45k	$0k	$0k	$45k

Earlier Directly-Related Contracts and Funding:

3.147.1 Field Testing of LiF (Mg, Cu, P) TL Dosimeters

It is proposed to conduct field trials of thermoluminescent dosimeters (TLD) that contain LiF (Mg, Cu, P) material at uranium mines, refineries, fuel fabrication plants, power reactors, and their proximate surroundings.

This project is proposed because laboratory testing of this TLD material at AECL-CRNL indicates: a sensitivity that is 25 times that of TLD-100 (and six times the sensitivity of the material currently used for dosimetry at CRNL); no supralinearity, as is characteristic of TLD-100; and linearity of response up to doses of 100 Gy. Therefore, dosimeters that use this detector material should provide much greater precision at low doses, and at least as great at high doses, as the TLD dosimeters currently in use in Canada. In addition the material should allow for better surface (skin) dosimetry.

It is anticipated that the findings of this study will lead to greater precision and sensitivity in personal and environmental dose measurements for beta and gamma radiation in Canada.

Proponent	UMD, RPD
Technical Advisor/Evaluator	UMD (B. Smart), RPD (G. Poirier)
Project Manager	E. Rabin
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$8k	$16k	$0k	$24k

Earlier Directly-Related Contracts and Funding:

7.139.1	$31000	$0	$0			$31000

3.148.1 Thorium Metabolism and Dosimetry - Literature Review

It is proposed to summarize and review, critically, the literature on intake, retention, excretion and health effects of thorium, with an emphasis on dose-effect (or intake-effect) relationships. The case of in vitro methods for predicting the biokinetics of thorium in man will also be examined.

Thorium is a bone-seeking element for which Annual Limits on Intake are very low. Thorium, in the form of natural Th-232 and in the form of its isotopes present in the uranium and thorium decay series, is present at all stages of the front end of the nuclear fuel cycle. Thorium has a number of industrial applications that can lead to the irradiation of workers where it is used. Consequently, a large number of persons among workers of the nuclear fuel cycle, non-nuclear industries, and members of the public are potentially exposed to intakes of thorium compounds. It is crucial that the AECB have updated information on the behaviour of thorium in the human organism and on the associated human health effects, as well as on in vitro methods used to determine the solubility and transferability of thorium in man.

It is anticipated that the study will provide the AECB with the information necessary to evaluate the health hazards presented by thorium, to determine appropriate regulatory limits on intake, and to provide guidelines for monitoring exposures to thorium.

Proponent	UMD, WMD, RPD
Technical Advisor/Evaluator	UMD (B. Smart), WMD, RPD (F. Horvath)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

4. URANIUM MINES AND MILLS

4.101.1 Study of the Health Effects of Inhaled Uranium Ore Dust

It is proposed to provide funding for the ongoing project to study the health effects (cancer mortality and histological defects) on experimental animals exposed to different concentrations of long-lived radioactive dust, such as those encountered in the uranium mines in Ontario and Saskatchewan.

The study is proposed because Canadian uranium miners are occupationally exposed to long-lived dust (containing uranium, thorium and their long-lived daughters), and the contribution of this exposure to the incidence of cancer is not fully understood.

The results of this study will be used to interpret the health effects of long-lived dust on uranium miners and to develop regulatory guidelines for controlling exposures to long-lived radioactive dust.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	P. Duport
Review Panel	3
Contractor	MacLaren Plansearch Inc.
Principal Investigator	A. Van der Vooren
Category	1*

Past	88/89	89/90	90/91	Future	Total
$435k	$238k	$143k	$150k	$303k	$1269k

Earlier Directly-Related Contracts and Funding:

4.103.2 Physical Characteristics and Solubility of Long-Lived Airborne Particulates in Uranium Producing and Manufacturing Facilities

It is proposed to continue funding this project to determine experimentally the size distribution, the activity distribution and the solubility of airborne uranium-bearing aerosols in all Canadian uranium mines and mills, refineries, conversion facilities and fuel fabrication plants.

This work is proposed to quantify the hazard presented by airborne radioactive long-lived materials in the concerned facilities. The parameters (size distribution, activity distribution, radionuclide composition and dissolution rate in simulated lung fluid) which are necessary to calculate the committed effective dose equivalent from exposure data must be determined in order to evaluate quantitatively this specific radiation hazard.

It is anticipated that this study will indicate the magnitude of the risk from long-lived particulates in uranium producing and manufacturing industries. It will also provide supporting information for any forthcoming regulation on long-lived dust and will facilitate interpretation of bioassay data for the purpose of the radiation protection of the workers at these facilities.

Proponent	UMD, FWD, RPD
Technical Advisor/Evaluator	UMD, FWD, RPD
Project Manager	K.P. Ho
Review Panel	5
Contractor	MacLaren Plansearch Inc.
Principal Investigator	A. Van der Vooren
Category	1*

Past	88/89	89/90	90/91	Future	Total
$25k	$93k	$116k	$36k	$0k	$270k

Earlier Directly-Related Contracts and Funding:

84.3.22	$49000	$0	$0			$49000

4.106.3 Ontario Miners Mortality Study - Phase III

It is proposed to continue funding the investigation of the cause of excess lung cancer among miners in Ontario, by updating the mortality analysis for Ontario uranium miners for the period from 1981 to 1986 and for gold miners from 1977 to 1986, in order to re-evaluate the risk of lung cancer per unit exposure of radiation.

This project is proposed because there is a need for an extension of the Phase II study (4.106.2) where excess lung cancer among gold miners and the influence of smoking on the incidence of lung cancer among uranium miners were investigated. The Phase II study recommended that the mortality analysis of gold miners should be extended from 1977 to 1986 to evaluate the impact of gold mining experience on the risk estimate for lung cancer among uranium miners.

It is anticipated that the results of the study will be used to improve the risk estimates for radiation-induced lung cancers. (This is a joint project with the Workers' Compensation Board of Ontario and Ontario Ministry of Labour, each of which will contribute $50k to the project during the two years.)

Proponent	UMD, RPD, HES, OML (R.A. Kusiak)
Technical Advisor/Evaluator	UMD (A. Dory), RPD (M. Measures, S. Ching)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	Ontario Ministry of Labour
Principal Investigator	R.A. Kusiak
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$25k	$25k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

4.106.1	$60000	$0	$0			$60000
4.106.2	$180000	$0	$0			$180000

4.108.1 Intercomparison of Dust Sampling Instruments

It is proposed to conduct a literature review, followed by laboratory and field intercomparisons, of the sampling characteristics of two cascade impactors (the Sierra #210 and the Marple Personal Cascade Impactor) which are used to determine the size distribution parameters of (Activity Median Aerodynamic Diameter (AMAD) and Geometric Standard Deviation (GSD)) aerosols. The objective is to evaluate the accuracy and reliability of the Marple Personal Cascade Impactor (in comparison with the more sophisticated Sierra #210) as a tool for verifying, at frequent intervals, the AMAD and GSD of long-lived radioactive dust in uranium-producing facilities. The adequacy of long-lived dust samples (in terms of the total radioactivity) as measured by a portable cyclone instrument and the CEA Personal Alpha Dosimeter (PAD) will be evaluated against open face and cascade impactor samples.

This project is proposed because the AECB is considering using the combined formula recommended in the ICRP Publication 30 for calculating the Committed Effective Dose Equivalent (CEDE) received by uranium workers. Since the Annual Limit on Intake (ALI) for long-lived dust is a function of the AMAD of the aerosols and in order to calculate the radiation doses due to the inhalation of long-lived dust, it is necessary to know the total concentration of radioactivity in the air and the AMAD of the dust. Personal cyclones provide a measure of the dust particles in the size range from 0.5 micron to 5 microns, but neglect particles smaller than 0.5 micron and larger than 5 microns, which also contribute to the radiation dose. The fraction of the total dust collected by cyclones depends upon the AMAD and GSD of the total size distribution. The CEA-PAD provides a measure of the total radioactive dust concentrations but has not been evaluated for this purpose in Canadian facilities. In order to obtain the information necessary for determining individual radiation doses due to exposure to long-lived dust, it is therefore necessary: a) to determine the suitability and reliability of a personal cascade impactor, which will be used to verify the AMAD and GSD of long-lived dust at the work place; and b) to assess to what extent dust samples, collected with portable cyclones and the CEA-PADs, are affected by variations of the AMAD and GSD of the dust, and what impact variations of these parameters may have on dose calculations.

It is anticipated that this study will indicate whether the Marple Personal Cascade Impactor can be used for routine determination of the AMAD and GSD of long-lived radioactive dust in uranium mines and mills, how variations in the AMAD and GSD of the dust affect sampling characteristics of portable cyclones and CEA-PADs, and how variations of these parameters should be taken into account to calculate the doses attributed to long-lived dust from dust measurements taken with personal cyclones and CEA-Personal Alpha Dosimeters.

Proponent	UMD, RPD
Technical Advisor/Evaluator	UMD (K. Bundy), RPD (S. Ching)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$20k	$55k	$15k	$90k

Earlier Directly-Related Contracts and Funding:

4.112.1 Electrical Charge of Radioactive Aerosols in Uranium Mines

It is proposed to measure the fraction of positively and negatively charged aerosol particles carrying radon and thoron daughters, to determine the number of elementary charges carried by individual charged particles, and to relate these parameters to the ionization conditions and carrier aerosol parameters that prevail in underground uranium mine atmospheres.

The radiation dose delivered to the lung from inhaled radon and thoron daughters depends upon the deposition of these radioactive particles in the respiratory tract, which in turn depends on the size distribution and electrical charge of these particles. The aerosol size distribution itself is governed in part by the electrostatic attraction between ultrafine radon and thoron daughters and carrier aerosol particles generated by mining activities and diesel engines. Owing to the ionization induced by relatively large concentrations of alpha radiation emitters, the consequent phenomena (collectively referred to as "atmospheric electricity") play an important role in shaping the resulting radioactive aerosol actually inhaled by miners. To date, no study has been carried out in Canadian mines to determine the electrical properties of airborne radon and thoron daughters.

It is anticipated that the findings of this study will, for the first time, bring information to the AECB staff on the electrical state of radioactive aerosols in mines. This information may also be used in interpreting monitoring and dosimetry data and may serve to complement the computer modelling of mine atmospheres.

Proponent	UMD, HES, EMR (J. Bigu)
Technical Advisor/Evaluator	UMD (K. Bundy), RPD (S. Ching)
Project Manager	P. Dupont
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$20k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

4.113.1 Tracer Gas Method for Assessing Ventilation Efficiency

It is proposed to identify and test a tracer gas technique that is suitable for measuirng ventilation rates in underground uranium mines and mills. Phase I of the work includes identifying portable, rugged, and easy-to-use equipment that can function in underground mines and in mill environments, and that allows several measurements to be made in a short period of time. Phase II includes the acquistion and testing of the equipment at selected sites in a mine and mill.

This project is proposed because, in the performance of inspections of uranium mines and mills, AECB inspectors have encountered a number of situations where measurement of air flow directions or flow rates (for the purpose of evaluating the radiation protection efficacy of the ventilation system) has been difficult. Recent advances in the use of tracer gas techniques may be able to overcome the difficulties involved in performing these measurements in currently troublesome ventilation situations.

It is anticipated that a suitable tracer gas method (and related equipment) would permit AECB inspectors to evaluate more quickly and accurately the efficacy of ventilation systems of mine and mill licensees.

Proponent	UMD
Technical Advisor/Evaluator	UMD (D. Corkill), RPD (S. Ching)
Project Manager	P. Duport
Review Panel	
Contractor	CANMET Elliot Lake Laboratory
Principal Investigator	J. Bigu
Category	1*

Past	88/89	89/90	90/91	Future	Total
$25k	$30k	$5k	$0k	$0k	$60k

Earlier Directly-Related Contracts and Funding:

4.116.1 Remote Control and Automation in Heavy Industry

It is proposed to conduct a literature review of the applications of remote control techniques and robotics in the mining industry, with an emphasis on mining and maintenance equipment. The study will also include a survey of remote control and robotic equipment currently in use in other heavy industries. The study will be international in scope and provide a brief overview of typical installations and their viability, including technical documentation, whenever available, as well as the names and addresses of suppliers of such equipment.

The review is proposed because the development of high-grade uranium operations in Western Canada will necessitate an assessment, by the AECB, of state-of-the-art applications of such equipment, to minimize worker exposure to radiation. The study will indicate trends, successes and shortcomings in the application of this equipment, and identify facilities in which this equipment was or is still in service, and will provide the AECB with an up-to-date list of suppliers and relevant operating data.

It is anticipated that the study will provide AECB staff with the necessary information to assess to what extent the uranium mining companies, which are operating on high grade ore, are utilizing current technology in order to optimize their radiation protection practices.

Proponent	UMD
Technical Advisor/Evaluator	UMD (R. McCabe)
Project Manager	P. Duport
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

4.117.1 Evaluation of Long-Lived Dust Exposures from Silica Samples

It is proposed: a) to assess, from the available literature, to what extent dust samples (collected in Canadian uranium mines for the purpose of determining exposures to silica dust) are suitable for evaluating individual exposures to long-lived dust with an accuracy acceptable to the AECB; b) if warranted by the results of a), to determine experimentally the correlation between the mass of quartz collected (on total or respirable dust samples) and the alpha activity emitted by the long-lived radionuclides embedded in the dust particles; c) to determine the suitability and sensitivity of silica dust measurements for determining individual exposures to long-lived dust; and d) to evaluate the cost-effectiveness of the technically-acceptable monitoring method(s).

The implementation of the Proposed General Amendments to the Atomic Energy Control Regulations will require that each and every radiation hazard present in the work place be taken into account for the determination of individual exposures. In the case of the uranium mining and milling industry, this will require in particular that individual exposures to airborne long-lived dust be evaluated and entered together with gamma, radon daughter and thoron daughter exposures, into a formula from which individual doses and committed effective doses will be calculated. At present, there is no method used routinely in Canadian mines that is known to be able to provide reliable information on long-lived dust exposure. However, silica (or quartz) concentration in mine atmospheres is monitored routinely because of the risk to mine workers of silicosis. It is useful to study to what extent dust samples collected for silica monitoring are suitable for evaluating individual exposures to long-lived dust. In the event these samples are not suitable for evaluating individual exposures to long-lived dust with the required accuracy, alternate methods, such as random spot sampling and the use of personal integrating monitors should be tested in order to determine the most cost-effective technique to be used to meet the upcoming regulatory requirements.

It is expected that this study will indicate to the AECB whether current silica dust samples can be used to evaluate individual exposures to long-lived dust in uranium mines and mills. In the event these samples are found to be unsuitable for this purpose, the study will indicate the most cost-effective method to be used to meet the regulatory requirements.

Proponent	UMD, HES
Technical Advisor/Evaluator	UMD (B. Smart)
Project Manager	P. Duport
Review Panel	
Contractor	
Principal Investigator	
Category	2

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$10k	$0k	$35k

Earlier Directly-Related Contracts and Funding:

4.118.1 Evaluation of Exposure Records of Eldorado Uranium Miners

It is proposed to continue funding of the re-examination of the radon daughter exposures of miners who worked at Beaverlodge Uranium Mines (of the then Eldorado Nuclear Limited) in Saskatchewan for the period from 1952 to 1983, and who may have had previous exposures to radon daughters at other mines.

There is some concern about the accuracy of the exposure estimates used in recent epidemiological studies of the Beaverlodge uranium miners. Therefore it has become necessary to re-examine the exposures of individual miners, taking exposures received in other mines and work histories into account.

It is anticipated that the results of this study will be used with other specific epidemiological studies, of miners exposed to radon daughters, to improve risk estimates for lung cancer.

Proponent	UMD, RPD
Technical Advisor/Evaluator	UMD (D. Corkill), RPD (S. Ching)
Project Manager	V. Elaguppillai
Review Panel	17
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$25k	$30k	$0k	$0k	$55k

Earlier Directly-Related Contracts and Funding:

4.118.2 Mortality Analysis of Beaverlodge Uranium Miners from 1981-1987

It is proposed to update the mortality analysis of the uranium miners in Beaverlodge, Saskatchewan, from 1981 to 1987, using computerized linkage to the National Mortality Data Base at Statistics Canada. Additionally the cancer incidence data for this cohort from 1975 to 1987 will also be analyzed to improve the statistical significance of the mortality information which will be used to obtain revised risk estimates for lung cancer per unit exposure to radon daughters.

The risk estimate for lung cancer obtained from the previous mortality analysis of the Beaverlodge uranium miners for the period from 1950 to 1980 was about three times the values reported for the Newfoundland fluorspar miners, about three to six times the values reported for the Ontario uranium miners, and six to nine times the risk estimates obtained from the study of uranium miners in the Colorado Plateau. There is some concern, both nationally and internationally, about the accuracy of the risk estimate obtained from the study of Beaverlodge uranium miners. As a consequence, both the mortality data and radon daughter exposure estimates should be re-examined in order to reduce the uncertainties in the risk estimates. (The re-evaluation of radon daughter exposures is being carried out in another study.)

It is anticipated that the results of this study will improve the risk estimates for lung cancer due to exposure to radon daughters. (This is expected to be a joint study with the National Cancer Institute of Canada on an equal cost-sharing basis.)

Proponent	UMD, RPD, HES, NCIC (G. Howe)
Technical Advisor/Evaluator	UMD (D. Corkill), RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	
Principal Investigator	
Category	2

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$30k	$0k	$60k

Earlier Directly-Related Contracts and Funding:

4.118.1	$0	$30000	$0			$30000
7.095.1	$59000	$0	$0			$59000

4.119.1 Evaluation of Mine Ventilation Monitoring Devices

It is proposed to identify the devices that are currently available for continuous and instantaneous sampling of air velocity and pressure. A side-by-side comparison will be undertaken of accuracy, reliability and ruggedness of representative devices when these devices are subjected to environmental conditions similar to those found in underground uranium mines and in mills.

This study is proposed because ventilation systems used to reduce the radioactive contamination in mine and mill air must be maintained at their optimal performance, requiring continuous auditing by mine and mill staff. Some types of the traditional mechanical air velocity and pressure-measuring equipment are becoming obsolete and are being replaced by electronic devices. Information on the operating capabilities of modern devices, and their ability to provide accurate and reliable data when used in the cold, damp, dusty environments of underground uranium mines, and dusty atmospheres of uranium mills, is required by the UMD to assess the radiation protection methods used by licensees.

It is anticipated that the results of this study will enable the UMD to prepare a regulatory guideline, for use throughout the uranium mining industry, for the measurement of air velocities and pressures.

Proponent	UMD
Technical Advisor/Evaluator	UMD (D. Corkill)
Project Manager	E. Rabin
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$35k	$0k	$0k	$35k

Earlier Directly-Related Contracts and Funding:

4.120.1 Sensitivity of Bronchial Epithelial Cells to Alpha Radiation

It is proposed to investigate, by means of a search of the literature (human and animal data) and discussions with researchers currently active in the field, the sensitivities of bronchial epithelial cells to alpha radiation of energies of 8 MeV and below. The investigation will focus on the production of chromosome aberrations in cells and on induction of lung cancer.

This study is proposed because the process of inducing lung cancer in humans by exposure to alpha radiation (such as is believed to occur in uranium miners) is not well understood. The cells of the bronchial epithelium which, upon absorption of alpha energy, initiate the development of lung cancer have not been identified with certainty.

It is anticipated that the findings of this study will provide information that is pertinent to understanding the mechanism of lung cancer induction by radiation.

Proponent	RPD, HES, Sask. Dept. of Human Resources, Labour & Employment
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	E. Rabin
Review Panel	
Contractor	
Principal Investigator	
Category	3

	Past	88/89	89/90	90/91	Future	Total
	$0k	$0k	$20k	$0k	$0k	$20k

Earlier Directly-Related Contracts and Funding:

4.121.1	$89000	$28000	$0			$117000

4.121.2 The Proliferative Cells of the Human Bronchial Epithelium

It is proposed to detect and quantify mitotic (cell-dividing) events in the human epithelium at different airway levels in surgically removed lungs and in post-mortem specimens. The involvement of basal epithelial cells in maintaining epithelial integrity and altering in vivo physiological parameters of importance to radiation dosimetry will also be investigated.

This study is proposed because animal studies have indicated that several proliferating (actively dividing) cell types (small mucous granule cells, clara cells and others), in addition to basal cells, may play a dominant role in bronchial epithelial replacement. There are no comparable data about proliferating cell populations in human airways. It is widely believed that the more actively dividing cells are the more radiosensitive. Establishing the proliferative potential of human epithelial cell populations is crucial to the understanding of the susceptibility of cells to the effects of irradiation. Clarification of the roles played by basal epithelial cells in maintaining epithelial integrity may influence, significantly, physiological parameters used in radiation dosimetry calculations.

It is anticipated that the findings of this study will provide information of importance to understanding lung cancer induction, in uranium miners, from the inhalation of radon and thoron daughters and long-lived radioactive dust. (The estimated cost of this project is $85K. SSC will pay, through the Unsolicited Proposals fund, the first $45K of the cost. The AECB will fund, in FY 89/90, and in the amount of $40K, the latter portion of this work.)

Proponent	RPD
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	E. Rabin
Review Panel	7
Contractor	University of Manitoba
Principal Investigator	D.H. Bowden
Category	1*

	Past	88/89	89/90	90/91	Future	Total
	$0k	$0k	$40k	$0k	$0k	$40k

Earlier Directly-Related Contracts and Funding:

	Past	88/89	89/90	90/91	Future	Total
4.121.1	$74000	$43000	$0			$117000

4.124.1 Improved Statistics for Uranium Miners Epidemiology Studies

It is proposed to test a new computerized statistical method for analyzing the relationship between exposures to radon daughters and lung cancer mortality in Ontario uranium miners.

At present, risk factors for occupational exposure to radon daughters are derived from the observed lung cancer mortality in groups of cases falling into given intervals of exposure values. When statistical uncertainties are taken into account, it is always assumed that both expected mortality from lung cancer and exposure data are log-normally distributed. In fact, only exposure data are generally log-normally distributed, while the number of expected cancers follows a Poisson distribution. The use of more appropriate statistical methods when determining risk factors in epidemiological studies may lead to results that are more accurate, more reliable, and whose interpretation is less uncertain.

It is expected that the study will demonstrate that the proposed new statistical method reduces uncertainties in risk factors for occupational exposures to radon daughters and will provide reliable quantitative uncertainties for risk factor values. The first epidemiological study to be re-assessed using the improved statistical method is the Ontario uranium miner study.

Proponent	UMD, RPD, HES
Technical Advisor/Evaluator	UMD (K. Bundy), RPD (C. Pomroy)
Project Manager	P. Dupont
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

4.125.1 Exposure Rate Effectiveness for the Induction of Lung Cancer

It is proposed to investigate the exposure rate effectiveness for the induction of lung cancers among miners exposed to radon daughters. The exposure data for Ontario uranium miners, Newfoundland fluorspar miners, Beaverlodge and Port Radium miners, and for the U.S. and Swedish miners will be analyzed statistically to derive a relationship between the induction of lung cancers and the exposure rate (WLM/a) at which the miners were exposed to radon daughters at their respective work places.

Animal studies have shown that exposure to radon daughters at high exposure rates are more effective in inducing lung cancer than the corresponding exposures delivered at low exposure rates. This observation has not been demonstrated in human populations occupationally exposed to radon daughters. Since radon daughter concentrations in the underground uranium and fluorspar (St. Lawrence) mines during the early years of mining were substantially higher than those of today's miners, those miners were exposed at higher exposure rates. To date, no comprehensive analyses of the exposure data of the uranium miners in Canada and the U.S., fluorspar miners in Newfoundland, and iron ore miners in Sweden have been performed to facilitate a better understanding of the exposure rate effectiveness for the induction of lung cancer among miners exposed to radon daughters.

The results of this study will improve our understanding of the exposure rate effectiveness and risk estimates for the induction of lung cancer following exposure to radon daughters.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$35k	$10k	$0k	$45k

Earlier Directly-Related Contracts and Funding:

4.126.1 Computerized Mortality Search Procedures

It is proposed to fund the preparation of a technical report which will document the structure of the files, methodology, flow of information, and data quality control checks used in the 1986 mortality search update of the Ontario miners study.

This project is proposed because, in the past decade, computer linkage methodologies have been improved greatly and new procedures have been developed. Weights have been derived for the parameters to be matched, and more links have been generated by using intermediate files to facilitate the linkage. Because updates to the mortality data bases are being proposed to be done on a five-year basis, it would be a logical step to document the methods being used, to facilitate ease of future updates. The data from these studies are being used extensively, internationally, to improve the risk estimates for radiation-induced lung cancers.

The results of the technical report prepared could prove valuable for persons involved in any pooling of data on radiation workers. Recommendations for future improvements on record linkage will be made.

Proponent	RPD, HES, Statistics Canada (M. Fair)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

4.127.1 Rapid Determination of Radon Daughter Concentrations

It is proposed to test and compare four portable monitoring instruments, used to determine radon daughter concentrations, that are presently being used by the uranium mining industry and regulatory agencies in Canada. The instruments will be tested under conditions typically found in underground uranium mines to ensure that the results are comparable to those obtained from the modified Kusnetz method (the standard procedure for determining radon daughter concentrations) that is described in Regulatory Guide R-4.

There are presently available a number of instruments that provide a measurement of radon daughter concentrations in air within a matter of several minutes after the air sample is taken. Conversely, the current standard method of radon daughter concentration measurement, the modified Kusnetz method, requires a wait of at least 40 minutes after sampling before an air sample can be measured for radon daughter activity. Therefore, the use of an instrument that provides a rapid measurement would be beneficial to both industry and to regulators. However, there are usually a number of assumptions in the design of the instruments that allow for the rapid determination of radon daughters and these assumptions may not be applicable to every mine working environment. For example, the instrument might assume a constant gamma radiation field. Moreover, other extraneous factors, such as elevated gamma radiation fields or humidity, may also affect the results. To reduce the uncertainty associated with the use of these instruments, it is important that they be tested under both controlled and actual mine conditions to ensure that they meet the accuracy and precision of the standard method. The instruments to be evaluated include the EDA WLM-30, the MDA Instant Working Level Meter, the Mimil II Alpha Monitor, and the Pylon WLM Model UL-1000C.

If these instruments appear to be in good agreement with the current standard, then their use will provide additional capabilities for AECB inspectors and mining company personnel in measuring radon daughter concentrations.

Proponent	UMD
Technical Advisor/Evaluator	UMD (J. Hore)
Project Manager	E. Rabin
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

5. WASTE MANAGEMENT

5.115.1 Software Quality Assurance for Waste Disposal Models

It is proposed to survey the latest developments in quality assurance programs for software as applied to modelling. The survey would identify the best applicable methods for assuring the quality of software systems to be applied to nuclear waste disposal.

AECB staff will be required to assess licence submissions concerning the predicted performance of existing and proposed nuclear waste disposal facilities. Some of these performance predictions will be generated by software modelling packages currently under development by industry and government agencies. Confidence that all of the requirements associated with model design, development and testing have been identified and implemented, is dependent on the effectiveness of the software quality assurance programme.

The results of the survey will assist AECB staff in assessing the effectiveness of the quality assurance programme to be applied to a particular model and hence the degree of confidence associated with how the model will perform.

Proponent	CQAD, WMD
Technical Advisor/Evaluator	CQAD (D. Scrimger), WMD (P. Flavelle)
Project Manager	D.E. Connelly
Review Panel	12
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

5.119.1 Uncertainty in the Interpretation of Hydrogeologic Data

It is proposed to undertake an independent and critical review of the hydrogeological data obtained at the Atikokan site by AECL for the Concept Assessment phase of the Canadian Nuclear Fuel Waste Management Program. It is also planned to analyze and assess the interpretations made of the data and to examine alternative interpretations. The study is being conducted in order to assess the impact of: a) errors in measurement and data manipulation; b) different interpretations of hydrogeologic data; and c) different models in characteristic underground flow systems.

This study is proposed to help the AECB conduct an independent assessment of high-level waste disposal and to ensure that methods and reviews of modelling and databases used within the high-level waste program are internally consistent.

The results of this study will assist the AECB in reviewing the document to be submitted at the conclusion of the Concept Assessment phase of the Canadian Nuclear Fuel Waste Program.

Proponent	WMD
Technical Advisor/Evaluator	WMD (P.A. Flavelle)
Project Manager	J.L. Wallach
Review Panel	16
Contractor	INTERA Technologies Ltd.
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$23k	$17k	$0k	$0k	$40k

Earlier Directly-Related Contracts and Funding:

5.121.1 Calibration/Validation of FEMWATER/FEMWASTE on the Nordic Site

It is proposed to: a) compile the existing groundwater monitoring data (1979-1984) for the Nordic tailings site; b) set up a preliminary model with FEMWATER/FEMWASTE in order to define gaps in input values and actual field information; c) define a program for field and laboratory work based on the outcome of tasks a) and b) above (soil samples would be taken to determine hydraulic conductivities and retardation factors, and additional groundwater samples might be required in order to update the movement of contaminant plumes); and d) set up a final model with FEMWATER/FEMWASTE in order to calibrate and validate the model prediction with the actual field data.

Doses from abandoned uranium tailings sites are predicted using pathway analysis system models (such as UTAP). These models are generally probabilistic and require numerous runs; thus each pathway in the model is reduced to its simplest expression. Contaminant transport in groundwater systems proves to be the major pathway in most situations. FEMWATER/FEMWASTE is a finite element program that models the groundwater pathway in much greater detail than any system model. Although FEMWATER/FEMWASTE is highly regarded in the hydrology community, it has yet to be applied and validated on specific tailings sites.

The results of this study would enable AECB staff to demonstrate the applicability of FEMWATER/FEMWASTE to actual tailings sites and to obtain a calibrated, validated tool to assess independently licensee applications for the decommissioning of uranium tailings sites and also for low-level waste sites.

Proponent	WMD
Technical Advisor/Evaluator	WMD (S. Nguyen, W. Napier), RPD (C. Letourneau)
Project Manager	R. Avadhanula
Review Panel	11
Contractor	INTERA Technologies Ltd.
Principal Investigator	K. Raven
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$40k	$40k	$0k	$0k	$80k

Earlier Directly-Related Contracts and Funding:

5.125.1 Coupled Processes in the Assessment of Deep Disposal

It is proposed to acquire an appropriate computer code with which to study the behaviour of a hypothetical waste disposal vault in plutonic rock. The vault would be assumed to be subject to natural and engineered conditions resulting from its location and from the emplacement, within it, of irradiated fuel. Thermal, mechanical and hydrological mechanisms, acting in different combinations will be assessed.

This study is proposed to help provide a better understanding of the nature of the process controlling mass transport from high-level repositories in crystalline rock. In particular, it is hoped to determine whether the coupling of thermal, mechanical and hydrological mechanisms would contribute substantially to being able to accurately predict radionuclide migration. It is also planned to be able to determine which mechanisms, when coupled, have the greatest effect.

The results of this study will assist the Waste Management Division in preparing for its review of the documents to be received at the conclusion of the Concept Assessment phase of the Canadian Nuclear Fuel Waste Management Program.

Proponent	WMD
Technical Advisor/Evaluator	WMD (S. Nguyen, P.A. Flavelle)
Project Manager	J.L. Wallach
Review Panel	10
Contractor	Acres International Limited
Principal Investigator	H. Tammemagi
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$58k	$22k	$0k	$0k	$80k

Earlier Directly-Related Contracts and Funding:

5.127.1 Radionuclide Concentrations in Fish: Serpent River Basin

It is proposed to obtain samples and determine the radionuclide concentrations in fish and in the associated water and sediments taken from the fish-stocked lakes found downstream of the Elliot Lake uranium mines in the Serpent River Basin. Further, it is proposed that transfer parameters be calculated for each radionuclide (from sediments to water to fish to consumer) and that dose to humans consuming these fish be estimated.

Transfer parameters for the uranium and thorium decay series in aquatic ecosystems are important components in the estimation of public dose arising from uranium mining activities. Results of a recent report, 'Survey of Data on the Radionuclide Content of Fish in Canada' INFO 0231-1, indicated that data on thorium and its isotopes were sparse, that there were very few studies of radionuclide concentrations in fish and associated water and sediment, and that there have been very few studies on these subjects conducted in Ontario. The results clearly suggest that there are definite gaps in important information useful in reliably estimating the dose to the public resulting from consumption of fish in the Elliot Lake area, which accounts for all of Ontario's uranium production.

The results of this study will provide reliable data on the transfer of radionuclides from aquatic pathways to humans.

Proponent	WMD
Technical Advisor/Evaluator	WMD (W. Napier, B. Zgola), RPD (C. Letourneau)
Project Manager	R. Avadhanula
Review Panel	11
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$70k	$0k	$0k	$70k

Earlier Directly-Related Contracts and Funding:

5.110.1	$25000	$0	$0			$25000

5.129.1 Decommissioning of Open Pit Mines - Literature Survey

It is proposed to conduct a literature survey of the decommissioning of all open pit mines, irrespective of the exploited mineral resource. The study would therefore include both uraniferous and non-uraniferous deposits.

This study is proposed because there are several open pit mines in Saskatchewan that will be decommissioned within the next year or two. These mines contain arsenic and nickel as well as uranium and it is desired to know what has been required by regulatory bodies and what has been done to effect decommissioning in the past.

It is anticipated that the results will be used to aid the AECB in assessing approaches and strategies for decommissioning proposed by licensees.

Proponent	WMD
Technical Advisor/Evaluator	WMD (R. Maloney)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

5.130.1 La Liquéfaction des Résidus de l'Uranium

On propose d'étudier le comportement dynamique et le potentiel de liquéfaction des résidus de l'uranium, ainsi que l'influence de ce comportement dynamique et de la liquéfaction sur la stabilité des barrages lors d'un séisme.

Cette étude a été proposée car les résidus de l'uranium d'Elliot Lake en Ontario sont déposés dans les lacs ou les dépressions sous forme de boue à haute teneur en eau. On s'attend donc à ce que la nappe phréatique demeure élevée à l'intérieur de ces résidus pour une période prolongée, après leur déclassement. Aux points bas de ces lacs ou ces dépressions, des barrages en terre et enrochements sont construit pour retenir ces résidus. Comme la région d'Elliot Lake présente un risque simique non-négligeable, la stabilité dynamique de ces barrages doit être examinée, surtout pour la période ultérieure au déclassement. Lors d'un tremblement de terre, l'eau dans les pores de la masse de résidus n'a pas le temps de se redistribuer à cause de la fréquence élevée des sollicitations sismiques. Ceci peut résulter en une augmentation de la pression interstitielle qui entraine une reduction de la résistance intergranulaire. Au delà d'un certain niveau, cette résistance peut devenir nulle, et la masse des résidus peut atteindre un état pratiquement fluide, l'état liquéfié. Dans ce cas la pression, exercée par la masse des résidus sur les barrages, peut augmenter jusqu'a ce qu'une rupture catastrophique puisse se produire.

Nous anticiperons que les résultats permettront au personnel scientifique de la CCEA d'obtenir une méthodologie et des outils prouvés pour examiner la stabilité sismique des barrages de résidus miniers de la région d'Elliot Lake. Cette méthodologie pourra aussi être aisément adaptée aux sites d'enfouissement de déchets à faible activité en Ontario comme, par exemple, Chalk River.

Proponent	WMD
Technical Advisor/Evaluator	WMD (S. Nguyen)
Project Manager	J.L. Wallach
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$50k	$0k	$100k

Earlier Directly-Related Contracts and Funding:

6. NON FUEL CYCLE APPLICATIONS

6.102.1 Radiation Doses to Technologists from Radiotherapy

It is proposed to measure and compare the radiation doses received by radiotherapy technologists during performance of their duties on two different types of treatment machines (high energy accelerators and cobalt 60 machines). The aim of the project is to determine: a) the doses received by technologists working on cobalt 60 and high energy linear accelerators (>20 MeV); b) the dose uniformity amongst technologists (since the dose results from the "head" of the machine which is normally above the technologist, the dose to the upper part of the body could be significantly higher than to the waist area where the TLD badge is often worn); and c) the contributions to the exposure from working inside the treatment room during the setting up of patients and from working at the control console of the machine.

This work is proposed because, in order to reduce the radiation exposure received by technologists in a radiotherapy department, it is necessary to identify the significant sources of exposure and their relative magnitudes. Also, the radiation exposures attributed to technologists may vary from machine to machine implying that there may be significant differences in exposure at the various machines.

It is expected that the proposed research will provide information on the relative exposure received by technologists working on the different types of therapy machines From this information, the AECB may be able to infer the mechanism by which the technologists receive the major part of their personal exposures. This information is essential in order to effect changes aimed at reducing personal radiation exposures, including the re-assignment of pregnant technologists to those duties where exposure is minimized as well as to develop protocols aimed at reducing the radiation exposure to the technologists.

Proponent	RTD
Technical Advisor/Evaluator	RTD (W.R. Brown), OCRFD (A. Guilbaud), RPD (G. Poirier)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$35k	$16k	$0k	$51k

Earlier Directly-Related Contracts and Funding:

6.103.1 Beta-Gamma Counting of Ra-228/Ac-228 in Urinalysis

It is proposed to fund a project to determine experimentally the feasibility of using beta-gamma counting of Ra-228/Ac-228 as a means of routine urinalysis for thorium.

This project is being proposed because, while there are several dozen workers (e.g., thorium mantle workers and uranium mill workers in Elliot Lake) occupationally exposed to thorium, present urinalysis measurements for thorium are done by colourimetric analysis whose sensitivity is about 20 micrograms/L, which is inadequate for a routine bioassay program for thorium.

It is anticipated that the results of this study will determine whether the proposed beta-gamma counting for Ra-228/Ac-228 can provide significant improvement in sensitivity over the present chemical process (i.e. colourimetric analysis) and also whether the proposed beta-gamma counting method can be used for a routine bioassay program.

Proponent	UMD, RPD
Technical Advisor/Evaluator	UMD (B. Smart), RPD (C. Pomroy)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$0k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

6.104.1 Production of a Hospital Radiation Safety Officer's Handbook

It is proposed to continue the funding to produce a handbook for use in Canadian hospitals by the hospital Radiation Safety Officer (RSO).

This work is proposed because the AECB has recently amended the policy regarding the uses of radionuclides in hospitals and has restated the role of the RSO. As a result, the certification of Registered Technologist of Nuclear Medicine (RTNM) is now considered as sufficient proof of competence for a RSO position.

It is anticipated that the production of this handbook will be used as a reference manual by Radiation Safety Officers and that the manual will contain diverse technical and regulatory information useful in the daily activities of a RSO. (This project will be funded jointly with SSC. Their contribution will be provided in FY 87/88 and it is to be approximately $15K of the total project cost; the AECB will contribute the remaining amount.)

Proponent	RTD
Technical Advisor/Evaluator	RTD (W.R. Brown), RPD (R. Irwin)
Project Manager	K.P. Ho
Review Panel	
Contractor	Canadian Radiation Protection Assoc.
Principal Investigator	W. Spiers
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$5k	$26k	$0k	$0k	$31k

Earlier Directly-Related Contracts and Funding:

6.105.1 Radiation Exposures of Non-Monitored Hospital Personnel

It is proposed to continue the funding to study the radiological impact of nuclear medicine patients on non-monitored hospital staff. The nuclear medicine patients are those who have had radioisotopes administered to them for the purpose of diagnostic medical examinations. The non-monitored hospital staff of interest in this study are workers who handle or are near nuclear medicine patients during the performance of their duties and who are not monitored for radiation exposures. Examples of these workers are ultrasound technicians, nurses and receptionists in nuclear medicine departments.

This study is proposed because there is a scarcity of information on radiation exposures for these specific job categories within hospitals. In order to assess doses and to verify whether the ALARA principle is being observed, the magnitude of exposures to these categories of workers should be known.

It is anticipated that the proposed research will provide information on the radiation doses and dose rates received by the various job categories. From the information obtained in this study, the AECB should be able to develop guidelines to reduce the radiation exposures, according to the ALARA principle, to non-monitored hospital staff. (This project will be jointly funded with SSC as follows: for FY 88/89 $30K by SSC and for FY 89/90 $41K by AECB.)

Proponent	RTD
Technical Advisor/Evaluator	RTD (M. Simard), RPD (G. Poirier)
Project Manager	K.P. Ho
Review Panel	18
Contractor	Université de Montréal
Principal Investigator	L. Renaud
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$41k	$0k	$0k	$41k

Earlier Directly-Related Contracts and Funding:

6.110.1 Dispersion from Fume Hood Exhaust Stacks

It is proposed to conduct a literature review on the dispersion characteristics of radioactive materials within 50 m of fume hood exhaust stacks.

This study is proposed because many radioisotope licensees have fume hood exhaust stacks and air intakes in the same general roof area. The current radioisotope laboratory design guide requires that the exhaust point must be 3 m above the roof level and more than 10 m from any fresh air intake. The adequacy of the current design guide is being questioned by some licensees.

It is anticipated that this literature review will provide information on the adequacy of the current design guide for radioisotope laboratories and will provide information on the relative importance of other factors such as the location of the air intake in relation to the location of the exhaust stack on the roof, its proximity to higher structures, design of the exhaust stack, and air velocity at the discharge location.

Proponent	RTD
Technical Advisor/Evaluator	RTD (R. Brown)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

7. HEALTH PHYSICS

7.093.1 Epidemiology of Lung Cancer Mortality in Canadian Mining Communities

It is proposed to fund the ongoing case-control pilot study of lung cancer deaths in uranium and non-uranium mining towns across Canada in which lung cancer mortality has been shown to be significantly elevated.

The study is proposed in order to attempt to find out to what extent various factors in the home and the workplace were responsible for excess cancer among miners and other residents of mining communities.

It is anticipated that the results of this study will be used to improve risk estimates for radiation-induced lung cancers. (A joint study with Statistics Canada and Health and Welfare Canada.)

Proponent	UMD, RPD, HES, NHW (D. Wigle), Statistics Canada (M. Fair)
Technical Advisor/Evaluator	UMD (K. Bundy), RPD (S. Ching)
Project Manager	P. Duport
Review Panel	
Contractor	Health & Welfare Canada
Principal Investigator	Y. Mao
Category	1*

Past	88/89	89/90	90/91	Future	Total
$70k	$0k	$3k	$0k	$0k	$73k

Earlier Directly-Related Contracts and Funding:

7.093.2 Epidemiology of Lung Cancer in Canadian Mining Communities (2)

It is proposed to resume a case-control epidemiology study of lung cancer mortality in Canadian mining communities, initiated in Timmins, Ontario, in 1984.

The original study was undertaken in order to identify the hazards responsible for an elevated (relative to the provincial average) incidence of lung cancer in the community. The main factor of risk being studied is long-term exposure to indoor radon daughters. The preliminary analysis of the earlier study showed a lack of correlation between 90 cases of lung cancer and domestic exposure to radon daughters. It is now proposed to study an additional 75 cases of lung cancer, and to double the number of controls for each case. The residential history of cases and controls will be traced back as far as possible.

It is expected that the results of this study will be used to reduce uncertainties in risk estimates for radon daughter-induced lung cancers, especially at low exposures. (This study will be co-funded by the Department of National Health and Welfare at a level of approximately $30k per year.)

Proponent	UMD, RPD, HES, NHW (D. Wigle)
Technical Advisor/Evaluator	UMD (K. Bundy), RPD (S. Ching, C. Pomroy)
Project Manager	P. Duport
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$45k	$45k	$30k	$120k

Earlier Directly-Related Contracts and Funding:

84.8.7	$78000	$0	$0			$78000

7.101.1 The Canadian National Dose Registry Study

It is proposed to continue funding the project to conduct an epidemiolgical study of cancer mortality among some 300,000 Canadians occupationally exposed to low levels of ionizing radiation, by developing a suitable linkage between the Canadian National Dose Registry and the Canadian Mortality Data Base.

This study is intended to find out whether there is any excess cancer mortality among certain groups of workers, such as Nuclear Medicine Technicians and Radiographers, who have not been studied so far in sufficient detail. This study of 300,000 radiation workers is likely to provide further information towards a better understanding of the dose-response relationship for low doses of ionizing radiation.

It is anticipated that the results of this study will be used to verify risk estimates for radiation-induced cancer mortality. (This is a joint study with the Department of National Health and Welfare and Statistics Canada. NHW has expended considerable resources both in dollars and person-years in support of this project. The expenditure by NHW (estimated to be $1,211K) is in addition to the funds expended by the AECB.)

Proponent	RPD, HES, NHW (P. Ashmore), Statistics Canada (M. Fair)
Technical Advisor/Evaluator	RPD (M. Measures)
Project Manager	K.P. Ho
Review Panel	
Contractor	Statistics Canada
Principal Investigator	M. Fair
Category	1*

Past	88/89	89/90	90/91	Future	Total
$219k	$60k	$35k	$10k	$0k	$324k

Earlier Directly-Related Contracts and Funding:

7.106.2 Effects on Central Nervous System from In Utero Exposure

It is proposed to fund a full-scale study of the health effects on the central nervous system (CNS) of experimental animals (rats and monkeys) following in utero exposure to ionizing radiation. Pregnant animals will be exposed to different doses and dose rates of ionizing radiation at different stages of gestation and the corresponding morphological and physical changes in the brain will be assessed quantitatively.

It is anticipated that an increasing number of young women will seek employment in the Canadian nuclear industry, where, in some cases, exposure of embryos or fetuses may occur. Very little information is available in the literature about the effect of in utero irradiation on the function and structure of the central nervous system. A feasibility study (84.8.8) completed in 1986 recommended a full-scale study to make quantitative estimations of the risk of health defects on the CNS following in utero irradiation taking dose, dose rate, and the stage of gestation into account. The Review Panel is also awaiting the results of 7.105.1 from which neuro-histological information (from humans) is needed in order for the present study to commence.

The results of the full-scale study will be used to improve risk estimates for radiation-induced developmental defects.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	1
Contractor	
Principal Investigator	
Category	2

	Past	88/89	89/90	90/91	Future	Total
	$0k	$0k	$30k	$70k	$200k	$300k

Earlier Directly-Related Contracts and Funding:

84.8.8	$22000	$0	$0			$22000

7.110.1 Screening of Human Populations for Abnormal Radiosensitivity

It is proposed to continue funding the project which is intended to develop a relatively inexpensive and rapid assay to screen for inherited differences in radiosensitivity of individuals.

This project was proposed because in recent years, there has been "increasing recognition that there are human genotypes that confer both increased cancer risk and abnormal cellular sensitivity on exposure to carcinogenic agents, including ionizing radiation". Subgroups of human populations possessing these genotypes affect the distribution of risk. Depending on the degree of heightened sensitivity, the average dose-response relationship may significantly underestimate the risk for low dose or low dose-rate exposure of the sensitive individuals. The carriers of the "defective" genotypes are often not identifiable by common clinical tests. An ability to detect such persons on an occupation-wide basis could lead to improved protection for radiation workers and greater comprehension of how risk is distributed. An appreciable side-benefit could accrue from the practical application of such a screening assay: persons identified as "normal" would be somewhat less at risk than was previously supposed. The principle of such an assay currently exists in the cultured fibroblast, colony-forming ability assay. However, the fibroblast assay is too labour-intensive and expensive (estimated cost approximately $5,000 per strain (assay procedure) to test for [illegible]sitivity to ionizing radiation) to be used in screening large numbers of persons. [illegible]nally too slow (establishment of the primary culture and survival analyses can ta[illegible] months).

It is anticipated that the results of this study will lead to a technique for routine screening for inherited differences in radiosensitivity of subpopulations of radiation workers and others. Information obtained from routine screening of these subpopulations may impact upon the exposure-risk estimates currently forming the basis for the AECB occupational limits for exposure to ionizing radiation, owing to a necessary re-evaluation of the distributions of risk derived from epidemiological studies. (This is a joint study with AECL on an equal cost-sharing basis.)

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	E. Rabin
Review Panel	8
Contractor	Atomic Energy of Canada Ltd. - CRNL
Principal Investigator	N. Gentner & D. Morrison
Category	1*

	Past	88/89	89/90	90/91	Future	Total
	$189k	$83k	$80k	$0k	$0k	$352k

Earlier Directly-Related Contracts and Funding:

7.110.2	$0	$2320	$0			$2320

7.111.1 In Vitro and In Vivo Studies of the Effects of Ionizing Radiation on the Developing Central Nervous System

It is proposed to continue funding the in vitro and in vivo studies of the effects of exposure to external gamma radiation on the developing central nervous system of rat and monkey embyos, using whole embryo culture.

It is anticipated that an increasing number of Canadian women will seek employment in the nuclear industry where, in some cases, exposure of embryos or fetuses may occur. Although mental retardation has been found to be the major developmental defect among those who received in utero exposure in the nuclear bomb explosions in Japan, very little information is available in the literature about the effect of radiation on the function and structure of the brain. This study will help in the understanding of the problem.

It is anticipated that the results of the study will assist in the quantification of the risk of an in utero exposure to ionizing radiation on the developing central nervous system. (The University of Manitoba and the Children's Hospital Research Foundation of Manitoba will contribute $160K to the project over the three years. In addition, a SSC contribution of $60K from its Unsolicited Proposal Fund was received for the year 1987/88. NHW also committed $10K for this project.)

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	V. Elaguppillai
Review Panel	1
Contractor	University of Manitoba
Principal Investigator	T.V. N. Persaud
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$80k	$69k	$0k	$0k	$149k

Earlier Directly-Related Contracts and Funding:

7.116.1 Cancer Morbidity Follow-Up Feasibility Study

It is proposed to determine the feasibility of using computerized record linkage with national cancer incidence data available in Canada for individual medical follow-up studies by attempting to link the National Dose Registry with the Alberta Cancer Registry and to determine any association between occupational radiation exposure levels and cancer incidence. This would be of particular assistance in developing the potential future use of the Canadian Cancer Data Base.

This feasibility study is proposed because cancer data will greatly assist the AECB in determining whether any excessive health effects or risks exist due to exposure to certain potentially hazardous environmental, occupational or other factors. This information will both complement and supplement mortality data available through the Canadian Mortality Data Base by providing a more sensitive measure (than mortality data alone) of the differences in risk from exposure to potentially hazardous environmental, occupational or other factors and a possible earlier detection of any potential health hazard. It will allow for earlier preventive measures to be introduced in the workplace for current as well as future employees.

It is anticipated that this study will provide the AECB with: (i) the ability to draw upon more cancer data from Canadian sources; and (ii) the opportunity to detect the occurrence of any non-fatal or rare cancers. In addition, it will assist the AECB in identifying areas of occupational, environmental, and other health risks for the general public. It will aid the AECB in its regulatory activity, and will also help in providing information for the assessment of exposures and occupational hygiene practices.

Proponent	HES, Statistics Canada (M. Fair)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$20k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

7.117.1 Hospital Record-Keeping System for Epidemiological Studies

It is proposed to conduct a feasibility study to modify hospital record-keeping systems to facilitate inexpensive case-control epidemiological studies of radiation-induced cancers.

Case-control studies of radiation-induced cancer can be conducted inexpensively using hospital records. However, the record-keeping systems in Canadian hospitals are not currently in a format to facilitate such studies.

It is anticipated that the results of the study will determine the feasibility of modifying hospital record-keeping systems to facilitate epidemiological studies. If the modification is feasible, several epidemiological studies of radiation-induced health effects can be conducted inexpensively to improve the corresponding risk estimates.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	2
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$20k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

7.118.1 Selection of Control Groups for Epidemiological Studies

It is proposed to fund the development of a unified system of selecting control groups for use in epidemiological studies of radiation-induced health effects.

One of the major problems in interpreting the results of epidemiological studies of groups exposed to ionizing radiation is the general lack of comparability between different studies of similar groups. The main source of the problem is the variation of the quality of control groups used in the different studies. It is therefore essential to develop a comprehensive system or methodology for selecting control groups for use in Canadian epidemiological studies of radiation-induced health effects. Lack of uniformity in selecting control groups has also been recognized as a weakness in epidemiological studies in other countries.

It is anticipated that the results of this study will provide a unified system or methodology for selecting control groups for use in epidemiological studies of radiation-induced health effects.

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	2
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$25k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

7.119.2 Full-Scale Epidemiological Study of Thyroid Cancer from I-131 Exposure

It is proposed to continue funding the epidemiological study of thyroid cancer among Canadians who were exposed to radioactive iodines during diagnostic examinations.

This project is proposed because risk estimates for radiation-induced thyroid cancer are largely based on the incidence among those exposed to X-radiation. There is some controversy as to whether or not the same doses of I-131 and X-radiation are equally effective for the induction of thyroid cancer. A pilot study (84.8.13), jointly funded by the Alberta Cancer Board and the AECB, recommended a full-scale study at the national level to investigate the relative biological effectiveness of X-radiation and I-131.

The results of the study are expected to refine the risk estimates for radioiodine-induced thyroid cancers, and to determine whether or not equal (thyroid) doses of I-131 and X-radiation are equally effective in the induction of thyroid cancers. (This is a joint study with the ten provincial cancer registries, each contributing $50K, and the Department of National Health & Welfare which will contribute $271K to the project over the next two years.)

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	V. Elaguppillai
Review Panel	2
Contractor	G.B. Hill Statistics Inc.
Principal Investigator	G.B. Hill
Category	1*

Past	88/89	89/90	90/91	Future	Total
$47k	$60k	$50k	$0k	$0k	$157k

Earlier Directly-Related Contracts and Funding:

84.8.13	$61000	$0	$0			$61000

7.121.1 Cancer Mortality among Cardiac Catheterization Patients

It is proposed to continue funding a feasibility study of cancer mortality among nearly 3000 patients who were exposed to ionizing radiation during cardiac catheterization at the Hospital for Sick Children in Toronto during the period 1946-1965.

There have been reports suggesting an excess in the incidence of leukemia, breast and thyroid cancers among those who received exposures, as children, to low doses (50 - 300 mSv) of X-radiation during cardiac catheterization. No comprehensive epidemiological study has ever been undertaken to examine the relationship between the radiation exposures and the cancer mortality among those patients.

The results of this study will be used to improve the AECB's understanding of the dose-response relationship at low doses of ionizing radiation. At the end of this feasibility study, and depending on the adequacy of the results obtained, a full-scale study at the national level may be undertaken to improve the accuracy of the risk estimates derived from the feasibility study. (This is a joint project with the National Cancer Institute of Canda and the Ontario Cancer Treatment and Research Foundation (OCTRF) and the Hospital for Sick Children, Toronto, which will contribute jointly $65K to the project over the next two years.)

Proponent	RPD, HES, OCTRF (A. Clarke)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	Ontario Cancer Treatment & Research Fnd.
Principal Investigator	A. Clarke
Category	1*

Past	88/89	89/90	90/91	Future	Total
$15k	$61k	$20k	$0k	$0k	$96k

Earlier Directly-Related Contracts and Funding:

7.122.1 Computerized Linkage of National Cancer Incidence Data

It is proposed to develop a satisfactory format for the computerized record linkage of national cancer incidence data with personal identifiers of breast and lung cancer patients who were previously exposed to fluoroscopic radiation during pneumothorax examination for tuberculosis.

The reason for proposing a cancer incidence linkage is to identify cancers which have occurred in the cohorts, but which have not been the underlying cause of death, and therefore have not been identified in the usual mortality linkage. This approach has never been used in any epidemiological studies of persons exposed to ionizing radiation.

The results of this study will help to determine whether the occurrence of a particular type of radiogenic cancer in any way yields a different mortality pattern for the same cancer, arising from a non-radiogenic cause. This study may have an impact on the risk estimates which form the basis of the dose limits for ionizing radiation. (This is a joint project with National Cancer Institute of Canada and Statistics Canada, which will jointly contribute $100K to the project.)

Proponent	RPD, HES, NCIC (G. Howe), Statistics Canada (M. Fair)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	K.P. Ho
Review Panel	
Contractor	National Cancer Institute of Canada
Principal Investigator	G.R. Howe
Category	1*

Past	88/89	89/90	90/91	Future	Total
$25k	$30k	$30k	$35k	$0k	$120k

Earlier Directly-Related Contracts and Funding:

7.126.1 Use of An Employee Identification Questionnaire and Guide

It is proposed to fund a project which is intended to promote the use of the employee identification questionnaire and the user guide developed and tested in the project entitled "Standardization of Individual Identifying Information for Health Record Keeping Methodology" (7.108.1). With information collected in Phase II (of 7.108.1) which identifies the potential users for this questionnaire, methods will be selected for advising Canadian companies and agencies, as well as international agencies and committees with occupational health record keeping requirements, of the questionnaire with a view to encouraging its use to improve the possibilities as well as decrease the costs of long term medical follow-up.

This project is proposed, in particular, because the derived information is intended to be targeted at AECB licensees who are required to implement and maintain health record systems and who supply information on radiation doses to the National Dose Registry. It is also of practical use for facilitating follow-up after any emergency or accident e.g. Chalk River clean-up, Chernobyl, PCB spill, and for standardization of records for international collaborative studies e.g. Eldorado Nuclear, Ontario Miners, or for review by international bodies, such as ICRP and BEIR Committee.

It is anticipated that the results of the study will facilitate and encourage adequate on-going individual record keeping for the preparation of current and past employee nominal rolls as well as for special studies. In addition, it may form the basis of an unambiguous identification of the individual in conjunction with the collection of radiological and non-radiological exposure histories and work histories. These will allow for subsequent follow-up, by the AECB, of health outcomes (mortality, morbidity, and genetic effects), and will be of use for reporting purposes to registries (dose, exposure and disease), and for other legislative or regulatory requirements.

Proponent	HES, Statistics Canada (M. Fair)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

	Past	88/89	89/90	90/91	Future	Total
	$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

7.108.1	$80000	$0	$0			$80000

7.127.1 Dose Response of Human Lymphocytes to Radiation and Chemical Carcinogens

It is proposed to investigate the feasibility of using a flow cytometry method for measuring radiation damage in fresh (recently extracted) human lymphocytes, and to measure the damage produced by a combined exposure to radiation, delivered at doses in the occupational range, and to chemical carcinogens.

This project is proposed because currently there is uncertainty as to whether radiation and chemical insults act synergistically, independently, or whether the chemical carcinogens influence a cell's response to radiation insult. This project is intended to be an appropriate follow-on to 7.107.1, "A Feasibility Study on the Identification and Determination of Exposure Levels of Non-Radiological Carcinogenic Substances at Canadian Nuclear Facilities", as it will provide experimental evidence of synergism or lack thereof.

It is anticipated that the findings of this study will assist AECB staff in quantifying the modifying influences of chemical carcinogens on the responses of workers to occupational radiation exposure. (This project is proposed to be funded jointly with AECL. AECL and the AECB will each contribute 50% of the cost of the project for a total of $146K.)

Proponent	RPD, HES
Technical Advisor/Evaluator	RPD (F. Horvath)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$48k	$25k	$0k	$73k

Earlier Directly-Related Contracts and Funding:

7.107.1	$46000	$0	$0			$46000

7.128.1 The Relative Impact of Radiation-Induced Genetic Disorders

It is proposed to fund a study to determine the relative impact of different types of radiation-induced serious genetic disorders in terms of their respective loss of years of life expectancy by linking the B.C. Health Surveillance Registry Records with the Canadian National Mortality Data Base.

The study is proposed because the relative impact of different types of serious genetic disorders can only be compared on a common scale, such as in terms of their respective loss of years of life expectancy. To date, no comprehensive study has been done to derive the relationship between different types of genetic disorders and their respective loss of years of life expectancy in the Canadian context. The data base at the B.C. Health Surveillance Registry is considered to be a leading source in North America for such a complex analysis. Initiation of this study is awaiting the results of 7.109.1.

It is anticipated that the results of the study will enable the AECB to compare, on a common scale, the relative impact of different types of radiation-induced genetic disorders. (This is proposed to be a joint study with B.C. Ministry of Health and Statistics Canada, with AECB contributing 70% of the total cost.)

Proponent	RPD, UBC (S. Sheps), Statistics Canada (M. Fair)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$45k	$45k	$0k	$90k

Earlier Directly-Related Contracts and Funding:

7.130.1 Ionizing Radiation in Tumour Promotion or Progression

It is proposed to continue funding a study to determine whether ionizing radiation, delivered chronically to tissue, acts as a tumour-promoting or -progressing agent for chemically-initiated carcinogenesis. This animal study will be carried out on mice using beta irradiation of the skin.

This study was initiated because ionizing radiation has been tested only as an agent for cancer initiation, the first step in the multi-step carcinogenesis model. It has been demonstrated to be a skin tumour-initiating agent when irradiated cells were subsequently chronically exposed to a chemical tumour-promoting agent (phorbol ester). The action of radiation in the other two steps of carcinogenesis (promotion and progression) has not been tested, however. The possibility that ionizing radiation acts as a tumour-promoting agent is particularly relevant because of recent evidence implicating oxidizing free radicals as the chemical promoters of tumours. These free radicals are the same DNA-damaging species as are produced by ionizing radiation. This point is also particularly important to the Canadian nuclear industry. Skin is an organ which is constantly in contact with the environment, and human skin undoubtedly contains cells which are "initiated" as a result of DNA damage from chemicals, sunlight or previous ionizing radiation. Atomic Radiation Workers are chronically exposed to low doses of radiation. If ionizing radiation acts as a tumour-promoting agent, then chronic exposure would stimulate the initiated cells to form tumours. Such a mechanism would also apply to cells elsewhere in the body which may be in the initiated state and could be chronically exposed to radiation. Lung is another organ likely to contain initiated cells resulting from exposure to environmentally generated hydrocarbons, and is also subject to chronic exposure to radon gas. Similar concerns also apply to the possibility that ionizing radiation may act as a progressing agent. Recent evidence has indicated that the risk of a benign tumour progressing to a malignant carcinoma can be substantilly increased if the tumour is exposed to DNA damaging chemicals. Most mature humans have a variety of non-malignant skin tumours, most of which have a very low risk of progression to carcinomas. However, if chronic exposure to ionizing radiation causes sufficient DNA damage, the risk of progression of these tumours may be substantially increased.

It is anticipated that the results of this study of ionizing radiation as a tumour promoter or progressor will impact on risk assessments for atomic radiation workers and other workers who are chronically exposed to industrial or medical processes where radiation sources are used. (The study is being funded jointly by the AECB and AECL on an equal cost-sharing basis: AECB $85K, AECL $85K.)

Proponent	RPD
Technical Advisor/Evaluator	RPD (M. Measures)
Project Manager	E. Rabin
Review Panel	
Contractor	Atomic Energy of Canada Ltd. - CRNL
Principal Investigator	R.E. Mitchell
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$76k	$9k	$0k	$0k	$85k

Earlier Directly-Related Contracts and Funding:

7.131.1 MOSFET or Silicon Diode Based Personal Beta Dosimeters

It is proposed to determine: a) the feasibility of using MOSFET (Metal Oxide Semi-Conductor Field Effect Transistor) radiation detectors or silicon diodes to measure beta doses to the skin of individuals; and b) the suitability (i.e. sensitivity, ruggedness, etc.) of such devices for personal beta dosimetry.

This study is proposed because the Canadian intercomparison of thermoluminescent dosimeters, carried out by the Working Group on External Dosimetry at several nuclear reactor sites in Canada, found variations in skin dose measurements that could not readily be explained. The Working Group recommended that further research directed towards developing a beta dosimeter for shallow dose measurements be undertaken.

It is anticipated that the results of this study will lead to the development of a beta dosimeter capable of providing improved estimates of shallow skin dose. (This study is proposed to be funded equally by the AECB and AECL. The estimated total cost of the study would be about $52K; the AECB contribution would be about $26K. The work is proposed to be undertaken by AECL-CRNL.)

Proponent	RPD
Technical Advisor/Evaluator	RPD (G. Poirier)
Project Manager	E. Rabin
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$17k	$9k	$0k	$26k

Earlier Directly-Related Contracts and Funding:

7.132.1 Computerized Format for Pooling Radiation Exposure Records

It is proposed to transform the records of past exposures to both radiation and other carcinogens into a computerized format. Initially, the study will be confined to exposure records of Atomic Radiation Workers in Canadian nuclear power stations.

There is an increasing need for an international standardization of radiation exposure records to facilitate pooling of data for follow-up studies of persons occupationally exposed to relatively low doses of ionizing radiation. International experts agree that the data from various countries should be pooled together and analyzed comprehensively in order to arrive at more statistically significant risk estimates for radiation-induced cancers. Since Canada is a leader in mortality surveillance programs involving nuclear power station workers, upgrading of the data base into a universal computerized format is very appropriate.

The results of this study will enable the AECB to pool the exposure data of Canadian nuclear power station workers with similar data from other countries, and facilitate more comprehensive risk estimates for radiation-induced cancers and other effects.

Proponent	RPD, HES, UBC (T.W. Anderson)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$45k	$30k	$0k	$75k

Earlier Directly-Related Contracts and Funding:

7.133.1 Bone Cancer from Radionuclide Intake

It is proposed to conduct an epidemiological study of bone cancer incidence among Canadian children and young adults exposed to radium and other bone-seeking radionuclides in drinking water and food. In the first phase of the study, radium and other bone-seeking radionuclides in typical milk and food samples, obtained from areas where well water is used for irrigation purposes, will be measured. In a subsequent phase, a detailed case-control study of bone cancer incidence, in relation to total radium and other radionuclide intake, will be investigated.

A preliminary study of bone cancer incidence among Ontario residents has identified a suggestive association between the incidence of excess bone cancer and exposure to concentrations of radium in well water higher than the provincial average, which does not include the Great Lakes as a source of drinking water. Although the level of radium in the well water of all bone cancer cases was less than the NHW-recommended maximum concentration of 1 Bq/L, the total intake of radium and other radionuclides, mainly dietary intake, should be measured to derive a relationship between the total intake of these radionuclides and the incidence of bone cancer.

The results of this study are expected to provide a quantitative relationship between excess bone cancer and total radium and other radionuclides intake. (This is expected to be a joint study with NHW, Ontario Ministry of Labour, Ontario Ministry of the Environment and the Ontario Cancer Treatment and Research Foundation at a total cost for both phases of $900K, of which the AECB portion would be about $120K, approximately $60K of which is expected to be for Phase I and the balance for Phase II.)

Proponent	RPD, OCTRF, OML (M. Finkelstein)
Technical Advisor/Evaluator	RPD (C. Letourneau)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$40k	$40k	$40k	$120k

Earlier Directly-Related Contracts and Funding:

7.134.1 Threshold Effect of CNS Defects Due to In Utero Exposure

It is proposed to investigate, in a laboratory study, whether or not there exists a threshold effect for defects on the developing central nervous system (CNS) following in utero exposure to low doses of ionizing radiation, by measuring the ratio of brain to body weight of a suitable animal (newborn) as a function of doses received in utero.

Recent findings of the study of A-bomb survivors in Hiroshima and Nagasaki seem to suggest the possibility of the existence of a threshold for radiation-induced defects on the developing central nervous system, at very low doses. The results of some animal studies have also raised the possibility of the existence of a threshold for defects on the central nervous system for doses between 50-100 mSv received in utero. These findings are in disagreement with the assumed linear dose effect relationship for radiation-induced defects on the CNS.

The results of the study will be used to resolve the controversy about the existence of a threshold effect for radiation-induced defects on the central nervous system. In addition, the results will be used to improve the radiation protection practices for female Atomic Radiation Workers in Canadian nuclear facilities and radioisotope laboratories. (This is expected to be a joint study with the University of Texas, U.S. National Institutes of Health, and the Atomic Energy Control Board. The total cost of the study is about $275K, with an AECB contribution of $80K.)

Proponent	RPD, HES, U. of Texas (W. Schull)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	1
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$40k	$40k	$0k	$80k

Earlier Directly-Related Contracts and Funding:

7.135.1 Mechanism of Radiation-Induced Mental Retardation

It is proposed to conduct a laboratory experiment to study the effect of low doses of ionizing radiation on the migratory characteristics of neurons of mice and of non-human primates. Embryonic neural cells will be cultured, and exposed to different doses of ionizing radiation at different stages of neuronal development, and the subsequent changes in the cellular surface structures, the number of cells present to migrate, the rates and the extent of migration of the neurons will be assessed quantitatively using a variety of monoclonal antibodies.

Recently, magnetic resonance imaging and autopsy data have established that a substantial fraction of the radiation-related cases of mental retardation seen in Hiroshima and Nagasaki bomb survivors exhibits evidence of a gross impairment of neuronal migration, seen as ectopic grey matter, largely circumventricular in distribution. It is important to understand the relationship between exposures and impaired migration and the cellular and molecular nature of this impairment in order to derive a quantitative value for the risk of mental retardation following in utero exposure to ionizing radiation.

It is anticipated that the results of this study will provide quantitative information on the mechanism of the impairment of the neuronal migratory processes. This understanding will lead to a better estimate of the risk of mental retardation due to in utero exposure to ionizing radiation. (This is expected to be a joint study with the Radiation Effects Research Foundation of Japan, Kyoto Prefectural University of Medicine (Japan), and the University of Texas Health Sciences Center in Houston. The total cost of the project is about $280k, shared among all sponsors, with an AECB contribution of $70k over 30 months.)

Proponent	RPD, HES, U. of Texas (W. Schull), Kyota PUM-RERF (S. Fushiki)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	1
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$25k	$20k	$70k

Earlier Directly-Related Contracts and Funding:

7.136.1 Confounding Factors Associated with Breast Cancer Incidence

It is proposed to investigate the interaction between low-LET radiation and confounding factors such as smoking, dietary constituents and intake of drugs and hormones, on the incidence of breast cancer among women exposed to X-rays during fluoroscopic examination.

The currently used risk estimates for radiation-induced breast cancer are subject to a number of uncertainties because of inadequate accounting of the presence of confounding factors such as smoking, certain dietary constituents and intake of drugs and hormones. The National Cancer Institute of Canada has accumulated large quantities of data on these confounding factors as a result of their previous study of breast cancer associated with fluoroscopic examination. These data should be analyzed to evaluate the influence of the various confounding factors on the incidence of breast cancer.

The results of this study are likely to identify the confounding factors and their influence on breast cancer incidence and are likely to improve, ultimately, the risk estimates for radiation-induced breast cancer.

Proponent	RPD, HES, NCIC (G.R. Howe)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	Howe, G.R.
Principal Investigator	
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$40k	$5k	$0k	$0k	$45k

Earlier Directly-Related Contracts and Funding:

7.137.1 Study of Childhood Cancer following Maternal X-Irradiation

It is proposed to investigate the incidence of childhood cancer among (i) those children who had abnormal delivery (such as breech presentation) or birth defects (such as Down's Syndrome), but whose mothers were not subjected to irradiation during pregnancy, and (ii) those who receivefl in utero exposure to X-rays, both groups in comparison with suitably selected control populations.

Some controversial studies have indicated an association between maternal exposure to low doses of ionizing radiation and the incidence of excess childhood cancers. On the other hand, some recent studies have reported an association between abnormal pregnancy cases (such as breech presentation and Down's Syndrome) and excess childhood cancers, even in the absence of exposure to X-rays during pregnancy or delivery. It is therefore possible that the reported association between maternal irradiation and excess childhood cancer was essentially due to those cases of abnormal pregnancies and deliveries and not necessarily due to maternal irradiation on the incidence of childhood cancer.

The result of this study will improve our understanding of the qualitative association between childhood cancer and maternal irradiation and may improve the quantitative risk estimates for radiation-induced cancers.

Proponent	RPD, HES, UBC (T.W. Anderson)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	V. Elaguppillai
Review Panel	2
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$40k	$0k	$65k

Earlier Directly-Related Contracts and Funding:

7.141.1 RBE of Gamma Rays Delivered at Low Dose Rates

It is proposed to compare the relative biological effectiveness (RBE) of gamma rays and x-rays in accelerating the development of mammary cancers (adenocarcinomas) in rats, when the radiation is delivered in moderate doses (up to 1 Gy), at low dose rates (of the order of 0.008 Gy/hr).

This project is proposed because the primary hazards of exposure to low levels of radiation at low dose rate are generally considered to be the induction of cancer and of genetic changes. For these endpoints, a task group has recently suggested, in ICRU Report No. 40, that appropriate quality factors suggested for gamma rays and x-rays depend almost exclusively on laboratory studies on endpoints such as the induction of somatic mutations in micro-organisms (Tradescantia). Data obtained recently by Atomic Energy of Canada Ltd., Chalk River, suggest that doses of gamma rays up to about 1 Gy, delivered at dose rates of about 0.008 Gy/hr, have comparatively little effect on the appearance of mammary tumours in Sprague-Dawley rats. This surprising observation requires confirmation. If it can be substantiated, it would suggest that low doses of gamma rays, delivered at low dose rates, produce very few mammary cancers, i.e., the RBE of low doses of gamma rays, delivered at low dose rates, is effectively zero for induction of malignant breast cancers in rats.

It is anticipated that the findings of this study may provide justification for reducing the quality factor below the current value of unity for gamma rays delivered in low doses and at low dose rates. This would impact on the risk estimates for radiation-induced cancer for humans from exposure to gamma rays. (This project is proposed to be cost-shared with AECL on a 25/75 percent basis with a total project cost estimate of $244k.)

Proponent	RPD
Technical Advisor/Evaluator	RPD (C. Pomroy, F. Horvath)
Project Manager	E. Rabin
Review Panel	6
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$15k	$36k	$10k	$61k

Earlier Directly-Related Contracts and Funding:

7.142.1 Mortality Analysis of the Fluorspar Miners from 1985-1988

It is proposed to update the mortaltiy analysis of the fluorspar miners in St. Lawrence, Newfoundland, from 1985 to 1988. The risk of lung cancer per unit exposure to radon daughters will be recalculated using the additional mortality information and previously estimated exposures to radon daughters.

Since the previous analysis of lung cancer mortality to 1984, more deaths have occurred among fluorspar miners as a result of natural aging of the cohorts. Since the fluorspar miners were in a unique situation, in which they received neither exposure from gamma radiation nor from radioactive dust, it is important to analyze their mortality data to obtain improved risk estimates for lung cancer in a 'pure' radon daughter environment.

It is anticipated that the results of this study will further improve the risk estimates for lung cancer from exposure to radon daughters in the absence of gamma radiation and radioactive dust. (This is expected to be a joint project with the Department of National Health and Welfare and Statistics Canada.)

Proponent	UMD, RPD, HES, NHW (D. Wigle), Statistics Canada (M. Fair)
Technical Advisor/Evaluator	UMD, RPD (S. Ching)
Project Manager	V. Elaguppillai
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$10k	$0k	$35k

Earlier Directly-Related Contracts and Funding:

7.091.1	$170000	$0	$0			$170000

7.143.1 Canadian Cancer Data Base

It is proposed to link internally the Canadian Cancer Data Base file to identify multiple records of cancer incidence for the same individual. In addition, a set of microfiche of the Canadian Cancer Data Base will be created in various format sequences to facilitate manual checking of the results of the proposed study.

The reason for proposing this approach is to reduce the labour required when the cancer data files are being used in the follow-up of radiation studies, including the fluoroscopy study, the Eldorado nuclear cohort, and Atomic Energy of Canada Ltd. study.

The results of this study will help to determine whether the occurrence of cancer, where radiation was present, is significantly higher in a particular study group compared to others.

Proponent	RPD, HES, Statistics Canada (M. Fair)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$30k	$0k	$0k	$30k

Earlier Directly-Related Contracts and Funding:

7.144.1 Development of an "Index of Harm" for Canadian Workers

It is proposed to fund a study of the procedures for integrating data from multiple sources for the purpose of developing an "index of harm" for members of the Canadian workforce. Past procedures have yielded experience with data bases in which information has been extracted from two matched files. For present purposes, the concept needs expansion to include integration of multiple sources by utilizing cross referencing and new data base techniques.

Over the past few years, for the purpose of assessing radiation risk, use has been made of: a) study cohort files; b) death records indicating endpoints (particularly cancers); c) cancer registrations; d) taxation records indicating members of cohorts still alive; and e) the social insurance number index file providing identifiers needed for follow-up. In order to develop the "index of harm" one needs also to add possible workplace accidents, genetic effects, delayed and chronic morbidity, including renal failure. The purpose of the present proposal is to prepare a coordinated plan, describing how to create a consolidated cross reference list for individuals between such files, rather than treating them mainly in a piece-meal fashion two at a time. New storage devices, new equipment (e.g., the expanding capabilities of personal computers), new data developments (e.g., the National Work Injuries and Accident Program, the Canadian Renal Failure Register) and data base packages (e.g., ORACLE or RAPID) will be examined. These new developments should be generalized and made to accommodate new data sources as they become available. Confidentiality and policies which need to be addressed in utilizing the required data source will be outlined.

It is anticipated that this study will provide AECB with: a) a brief view of recent "index of harm" literature, such as ICRP Nos. 27 and 45, along with examination of the feasibility of drawing suitable statistical data from Canadian sources; and b) recommendations for procedures for coordinating existing data collection and data base development in Canada in order to produce "index of harm" data for radiation and other industrial workers.

Proponent	RPD, HES, Statistics Canada (M. Fair)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$35k	$0k	$0k	$35k

Earlier Directly-Related Contracts and Funding:

7.145.1 Screening Breast Cancer Patients for A-T Heterozygosity

It is proposed to fund a study to determine the percentage of women with breast cancer who are also carriers (heterozygotes) of ataxia telangiectasia (A-T), a recessively inherited multisystem disorder that results in a predisposition to lymphoproliferative malignancies and marked higher radiosensitivity, as demonstrated by intolerance to conventional radiotherapy. To this end, a prospective case-control study will be conducted on 200 breast cancer patients presenting pre-operatively at the Cross Cancer Institute, in Alberta, and an equal number of age- and parity-matched (parity in this context refers to the number of children the subject has given birth to) controls selected from healthy women undergoing noncancer-related gynecological examinations.

This study is proposed because it has been predicted (Swift, M., et al., N. Engl. J. Med. 316:1289, 1987) that as many as 18% of all women with breast cancer may be carriers of A-T. However, due to the rarity of A-T patients, it is estimated that only approximately 1.4% of the entire population (men and women taken together) are A-T carriers. Moreover, researchers have demonstrated that the radio-response of cultured fibroblast and lymphoblastoid cell lines from A-T heterozygotes (i.e., parents of A-T patients) to chronic Co-60 gamma irradiation indicates a heightened sensitivity, compared with cell lines from normal controls. Therefore, female carriers of A-T may make a disproportionately large contribution to the overall breast carcinoma group, and thereby skew the distribution of risk for radiogenic breast cancer.

It is anticipated that the findings of this work will refine the assessment of risk of breast cancer from exposure to low level radiation. (This study will be cost-shared between the AECB (35%), the Alberta Cancer Board (60%), and the Ataxia Telangiectasia Medical Research Foundation of America (5%).)

Proponent	RPD, HES, Cross Cancer Institute (M.C. Paterson)
Technical Advisor/Evaluator	RPD (C. Pomroy)
Project Manager	E. Rabin
Review Panel	8
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$50k	$50k	$150k

Earlier Directly-Related Contracts and Funding:

7.146.1 Effects of Radiation on Wild Birds Breeding: Tree Swallows

It is proposed to study the effects of low level chronic radiation exposure on breeding and other related end-points in tree swallows (Tachycineta bicolor) in their natural setting.

Results of several studies have raised concerns among national and international groups as to whether populations of organisms other than humans are indeed adequately protected at the level considered adequate for members of the public. A thorough understanding of the radiation sensitivity of organisms other than humans is therefore essential for planning and regulating the protection of the environment. Currently there are large gaps in the important information required to address these concerns, particularly on chronic low level radiation exposure of non-human organisms. Because of obvious difficulties, not all organisms can be investigated, especially in their natural settings. Therefore research efforts are often concentrated on the studies of key groups of species. Birds are one of the key groups of species which, because of their often close relationships with humans, are studied extensively in the field in relation to chemical pollutants in the environments. Birds are also ideally suited for studying radiation effects in a natural setting. Tree swallows are chosen for this study because they accept nest boxes set out in a grid in the environment, are relatively insensitive to human disturbances and have a short breeding cycle.

The results of this study will be used to ensure that environmental radiation protection principles are based on rational and systematically developed assumptions and measurements.

Proponent	RPD
Technical Advisor/Evaluator	RPD (C. Letourneau)
Project Manager	R. Avadhanula
Review Panel	11
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$70k	$0k	$0k	$70k

Earlier Directly-Related Contracts and Funding:

7.147.1 Contribution to Statistics Canada Workshop

AECB contribution to Statistics Canada for a workshop in 1989.

Proponent	
Technical Advisor/Evaluator	
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	1

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$3k	$0k	$0k	$3k

Earlier Directly-Related Contracts and Funding:

8. TRANSPORTATION

8.103.1 Testing of Foam Used in Packaging for Shock and Thermal Absorbency

It is proposed that samples of polyurethane foam, both cast in situ and from block, be tested for: a) energy absorption; b) load/deflection; and c) thermal resistance. Foams of different densities and from different manufacturing processes will be tested. It is expected that the load/deflector tests would be performed statically, but energy absorption should take into consideration dynamic loading.

Over the last decade there has been considerable use of polymer foam in the construction of packaging for radioactive material. This foam is used in three basic applications: impact limitation, thermal insulation, and moisture absorption. Foam is often made "in situ", filling fully closed cavities that exist in the structure. It is also supplied in bulk blocks and shapes. By alterations in materials, catalyst quantities and processes, it is possible to obtain a foam with certain required properties. Little information is available on the controlling parameters and the resulting properties. This makes difficult the enforcement of quality assurance of packaging by AECB staff.

From the results of these tests, AECB staff would be able to assess more accurately information supplied supporting applications for package and device approval. In addition, manufacturing controls can be determined with which to obtain the necessary level of quality assurance.

Proponent	RTD
Technical Advisor/Evaluator	RTD (D. Joseph)
Project Manager	R. Avadhanula
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$35k	$0k	$0k	$35k

Earlier Directly-Related Contracts and Funding:

9. REGULATIONS & REGULATORY PROCESS DEVELOPMENT

9.102.1 Review of Crisis Management Methods

It is proposed to continue a review of AECB operations and corporate planning and, based on the latest developments in crisis management, to determine which elements of crisis management should be included in corporate planning, and in the preparation of a crisis management manual.

Although there are AECB documents that deal with emergency response at the working level (e.g. duty officer's handbook, divisional operating procedures), there is no corporate document that deals with broader questions such as: - the establishment of a crisis team; - communications with the public, who handles it, and how? - chain of command in the absence of someone in the management structure; - interaction with other government agencies; - role of the AECB Emergency Response Coordinator.

The results of this review will assist AECB staff in updating corporate planning to address crisis management, and in preparing a detailed crisis management manual.

Proponent	EXEC
Technical Advisor/Evaluator	DFC (W.D. Smythe), PCS (T. Viglasky, T. Diamantstein)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$25k	$0k	$0k	$25k

Earlier Directly-Related Contracts and Funding:

9.103.1 Study of the AECB Long Range Plan for Information Management (I)

It is proposed to determine the technical feasibility and to design and prepare a plan for its implementation for the period March 1989 to 1993 of the AECB's strategy for document management, outlined in AECB "Strategic Plan for Information Management 1986-1991". Factors that will be taken into account for the technical feasibility and practicality of the "Strategic Plan for Information Management" include current and projected technologies, worker acceptance of the new technologies, legal issues and interface with external information providers to AECB.

This work is proposed because the AECB's long-term objectives for information management, particularly for the management of documents, represent a very significant departure from traditional practices. A detailed study of the technical feasibility and practicality of the "Strategic Plan for Information Management" must be established prior to the proposed implementation of the plan projected to take place during fiscal years 1989 to 1993.

The results of this project will enable the AECB to confirm the direction it will be taking on information management and to implement the long-range plan for information management.

Proponent	IMS
Technical Advisor/Evaluator	ADD (J. Waddington), IMS (W. Goodwin)
Project Manager	D.J. Martin
Review Panel	
Contractor	Stevenson, Kellogg Ernst & Whinney
Principal Investigator	K.A. Grant
Category	1*

Past	88/89	89/90	90/91	Future	Total
$73k	$77k	$60k	$0k	$0k	$210k

Earlier Directly-Related Contracts and Funding:

9.103.2 Implementation of a New File Classification System

It is proposed to design and implement a new universal indexing scheme for the AECB records management operation that allows ready access to information by AECB staff. This activity was a recommendation of the preceding project 9.103.1, "Study of the AECB Long Range Plan for Information Management".

The subject classification in the current indexing scheme makes it difficult for users to retrieve information on a particular topic. For example, records are often distributed across several different files and if the user does not know which files then the information is effectively unavailable. The problem is analogous to a library in which the books have been catalogued under broad and ambiguous classifications using informal cataloguing rules.

AECB staff and the public will be able to gain ready access to the knowledge base held in the records management system.

Proponent	PAB
Technical Advisor/Evaluator	PAB (W. Goodwin, J. Waddington)
Project Manager	D.J. Martin
Review Panel	
Contractor	
Principal Investigator	
Category	2

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$15k	$105k	$0k	$120k

Earlier Directly-Related Contracts and Funding:

9.103.1	$73000	$77000	$0			$150000
9.103.3	$0	$0	$80000			$80000

9.103.3 Implementation of New Information Management Plan

It is proposed to implement the new AECB Long Range Plan for Information Mangement resulting from project 9.103.1. The specific equipment, software, training, operational methods and implementation plan would be defined and described in detail and the contractor would assist AECB staff during the actual installation, training, and commissioning of the new systems.

Expert knowledge is required of the most effective means of carrying out the long range plan, from a useability and cost viewpoint. The AECB does not have sufficient in-house resources to do this.

This project would enable the AECB to implement on a timely and cost effective basis the systems and methods required to support the new Long Range Plan for Information Management.

Proponent	PAB
Technical Advisor/Evaluator	PAB (W. Goodwin, J. Waddington)
Project Manager	D.E. Connelly
Review Panel	
Contractor	
Principal Investigator	
Category	2

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$10k	$70k	$0k	$80k

Earlier Directly-Related Contracts and Funding:

9.103.1	$73000	$77000	$0			$150000
9.103.2	$0	$0	$120000			$120000

9.104.1 Regulatory Effectiveness Measurement System

It is proposed to investigate the feasibility of a Regulatory Effectiveness Measurement System (REMS) to determine what has to be measured in order to show how effective the AECB is in carrying out its regulatory mandate. This is to be achieved by defining what information (in general terms) is needed as an input to the AECB decision-making process to produce a comprehensive data model, and by defining the outputs of the model that would be used to evaluate the preferred process for decision-making. In addition, a prototype system for a typical area of interest (e.g. impact of the AECB program on the nuclear industry's safety record) is to be included as part of the scope of the study.

This study is being proposed recognizing the Government's initiatives to downsize the Public Service and to improve the management of regulatory programs, such as that of the AECB which costs approximately $23 million annually. The Government's initiatives will require increased efforts by the AECB to improve its productivity and ensure effectiveness of its activities. At the moment, for example, there is little evidence to correlate the safety record of the nuclear industry to AECB activities.

It is anticipated that the results of this project will demonstrate the feasibility of a high level management information system which could provide AECB senior management with an early warning system for potential problems and help to ensure the effective use of resources.

Proponent	ADD
Technical Advisor/Evaluator	ADD (J. Waddington), IMS (W. Goodwin)
Project Manager	K.P. Ho
Review Panel	
Contractor	
Principal Investigator	
Category	3

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$50k	$100k	$0k	$150k

Earlier Directly-Related Contracts and Funding:

9.106.2 A Review of the UCP System

A project is proposed which would take the results of a previous contract which described and documented the AECB Classification System and would propose changes to the system. The changes would ensure that the system is, in principle, fair, systematic and has no built-in biases against women or minority groups.

The AECB is in the process of reviewing the Classification System, to ensure the system conforms to government standards and regulations, particularly as it relates to salary equity.

The results of the contract would be used in the on-going evaluation and development of the AECB Personnel Classification System.

Proponent	PAB
Technical Advisor/Evaluator	PAB (J. Waddington)
Project Manager	D.J. Martin
Review Panel	
Contractor	
Principal Investigator	
Category	2

Past	88/89	89/90	90/91	Future	Total
$0k	$0k	$15k	$35k	$0k	$50k

Earlier Directly-Related Contracts and Funding:

9.106.1	$0	$16000	$0			$16000

9.112.1 Management of Risks & Socio-economic Impacts of Technology

A project is proposed which would elucidate the process of safety management in society and would develop a framework within which decisions regarding the management of risks may be improved through support by a more rational and scientific approach. The project is co-funded by Ontario Hydro and Atomic Energy of Canada Ltd.

There are at present widespread difficulties in arriving at decisions whenever safety is perceived by society to be an important factor. In large part, these difficulties arise because resolution of safety issues is in general isolated from the consideration of the benefits to be derived and again isolated from the risks of alternate courses of action. Better decisions can be reached if all the benefits and detriments of a course of action, and of alternatives to that course of action, are systematically assessed and weighed against each other.

The results of this project will contribute to fundamental thinking in the area of assessing risks in concert with benefits, with a view to improving the quality and defensibility of decisions relating to management of risks.

Proponent	Unsolicited Proposal, Institute of Risk Research
Technical Advisor/Evaluator	Z. Domaratzki, W.D. Smythe, R.M. Duncan
Project Manager	D.J. Martin
Review Panel	
Contractor	Institute of Risk Research
Principal Investigator	N. Lind
Category	1*

Past	88/89	89/90	90/91	Future	Total
$0k	$10k	$53k	$0k	$0k	$63k

Earlier Directly-Related Contracts and Funding:

FUNDING OF AECB REGULATORY RESEARCH & SUPPORT PROGRAM

BY MISSION OBJECT

(FY 89/90 ALLOCATION: $3,054K)

M.O. NO.	MISSION OBJECT	FY 89/90 ALLOCATION (K$)		
		CATEGORIES 1* & 1 & 2	CATEGORY 3	TOTAL
2	NUCLEAR REACTORS	1,280	1,065	2,345
3	OTHER FUEL CYCLE FACILITIES, GENERAL	574	388	962
4	URANIUM MINES AND MILLS	459	205	664
5	WASTE MANAGEMENT	199	55	254
6	NON FUEL CYCLE APPLICATIONS	102	80	182
7	HEALTH PHYSICS	424	575	999
8	TRANSPORTATION	-	35	35
9	REGULATIONS & REGULATORY PROCESS DEVELOPMENT	153	75	228
	TOTAL	3,191	2,478	5,669

LIST OF REVIEW PANELS FOR REGULATORY RESEARCH & SUPPORT PROGRAM PROJECTS

1. RADIATION-INDUCED DEVELOPMENTAL DEFECTS

Project Manager: V. Elaguppillai

In Progress:

In Vitro and In Vivo Studies of the Effects of Ionizing Radiation on the Developing Central Nervous System (7.111.1)

Planned:

Study of Birth Defects around Canadian Nuclear Facilities (3.136.1)

2. EPIDEMIOLOGY

Project Manager: V. Elaguppillai

In Progress:

Full-Scale Epidemiological Study of Thyroid Cancer from I-131 Exposure (7.119.2)

Childhood Leukemia around Canadian Nuclear Facilities (2.162.1)

Planned:

Study of Childhood Cancer following Maternal X-Irradiation (7.137.1)

3. INHALATION STUDIES

Project Manager: P.J. Duport

In Progress:

Study of the Health Effects of Inhaled Uranium Ore Dust (4.101.1)

4. DOSIMETRIC MODELS

Project Manager: P.J. Duport

In Progress:

Evaluation of Data and Models on Uranium Metabolism - Europe (3.111.1)

Evaluation of Data and Models on Uranium Metabolism - North America (3.111.2)

5. LUNG SOLUBILITY STUDIES

Project Manager: K.P. Ho

In Progress:

Physical Characteristics and Solubility of Long-Lived Airborne Particulates in Uranium Producing and Manufacturing Facilities (4.103.2)

Project Manager: P.J. Duport

Planned:

Influence of Macrophages on Dissolution of Uranium Compounds (3.123.1)

6. RELATIVE BIOLOGICAL EFFECTIVENESS (RBE)

Project Manager: E. Rabin

In Progress:

Measurement of RBE for Tritium for Myeloid Leukemia (2.154.2)

Planned:

RBE of Gamma Rays Delivered at Low Dose Rates (7.141.1)

7. BRONCHIAL EPITHELIUM

Project Manager: E. Rabin

In Progress:

The Proliferative Cells of the Human Bronchial Epithelium (4.121.2)

8. RADIOSENSITIVITY OF BIOLOGICAL SYSTEMS

Project Manager: E. Rabin

In Progress:

Screening of Human Populations for Abnormal Radiosensitivity (7.110.1)

Planned:

Screening Breast Cancer Patients for A-T Heterozygosity (7.145.1)

9. URANIUM TOXICITY

No 1989/90 Panel

10. HYDROGEOLOGY

No 1989/90 Panel

11. ENVIRONMENTAL PATHWAYS

Project Manager: R. Avadhanula

In Progress:

Transfer of Radionuclides to Human Milk - Phase 3 Field Study (3.106.3)

Calibration/Validation of FEMWATER/FEMWASTE on the Nordic Site (5.121.1)

Planned:

Measurement of Tritium in Canadian Food Items (3.135.1)

Radionuclide Concentrations in Fish: Serpent River Basis (5.110.2)

12. SOFTWARE RELIABILITY

Project Manager: D.E. Connelly

Planned:

Estimating Software Reliability for Reactor Shutdown Systems (2.134.1)

Software Quality Assurance for Waste Disposal Models (5.115.1)

13. GEOCHEMISTRY

No 1989/90 Panel

14. SEVERE ACCIDENTS

Project Manager: A. Omar

In Progress:

Consequences of Severe Accidents in Canadian Power Reactors (2.157.1)

15. NPP AGING

Project Manager: J. Pachner

Planned:

Ballooning of Heavily Hydrided Pressure Tubes (Phase 1) (2.166.1)

Aging of CANDU Heat Transport Pressure Boundary Components (2.168.1)

Reliability-Centred Maintenance Review of Safety Systems (2.169.1)

16. DEEP GEOLOGICAL DISPOSAL

Project Manager: J.L. Wallach

In Progress:

Coupled Processes in the Assessment of Deep Disposal (5.118.1)

Uncertainty in the Interpretation of Hydrogeologic Data (5.119.1)

An Evaluation of Contaminant Retardation Mechanisms (5.124.1)

17. EXPOSURE EVALUATION

Project Manager: V. Elaguppillai

In Progress:

Evaluation of Exposure Records of Eldorado Uranium Miners (4.118.1)

18. EXPOSURES OF NON-MONITORED PERSONNEL

Project Manager: K.P. Ho

In Progress:

Radiation Exposures of Non-Monitored Hospital Personnel (6.105.1)

LIST OF 1989/90 PROJECTS

2. NUCLEAR REACTORS

2.089.2	Computer Software Quality Assurance (II)
2.101.1	Instrument Behaviour under Off-Normal Conditions
2.102.1	A Tool to Analyze Real-Time Programs
2.105.1	Crack Propagation in Tough Ductile Materials
2.105.2	Crack Propagation in Tough Ductile Materials - Carbon Steel
2.108.1	Survey of NPP Environments for Equipment Qualification
2.111.1	International Piping Integrity Research Group
2.114.2	A Simulator for Evaluating Emergency Operating Procedures
2.117.1	Documentation of Real-Time Power Reactor Software (I)
2.117.2	Documentation of Real-Time Power Reactor Software (II)
2.118.1	Behaviour of the Calandria Structure under Severe Conditions
2.122.1	Non-Uniformity of Hydrogen in Fuelling Machine Vaults
2.123.1	Effect of Geometry on Hydrogen Burn in Calandria
2.127.3	Evaluation of Computerized Shutdown System Software (III)
2.127.5	Evaluation of Computerized Shutdown System Software (V)
2.129.1	Meteorological Monitoring Network for Pickering NGS
2.130.1	Self-Testing of Programmable Controllers & Microcomputers
2.132.1	Review of Software Configuration Management at Darlington
2.133.1	Review of the SLOWPOKE Demonstration Reactor Control System
2.134.1	Estimating Software Reliability for Reactor Shutdown Systems
2.135.1	In-Service Degradation of NPD Heat Transport Piping
2.136.1	Commercial Pressure Retaining Components in Nuclear Service
2.137.1	Hydrogen Combustion in Calandria
2.139.1	Aging of Cables in Nuclear Power Plant Environments
2.143.1	Mapping of NPD Rolled Joint Hydrides
2.146.1	Cold-Water Injection Loading in Two-Phase Systems
2.148.1	Propagation Mechanisms of Molten Fuel/Moderator Interaction
2.153.1	Computer Codes for Examining Circulation within Containment
2.154.2	Measurement of RBE for Tritium for Myeloid Leukemia
2.155.1	Maintenance: Means and Methods
2.157.1	Consequences of Severe Accidents in Canadian Power Reactors
2.158.1	Evaluation of Functional Specification Review Techniques
2.162.1	Childhood Leukemia around Canadian Nuclear Facilities
2.164.2	Review of Training Materials
2.165.1	Studies of Stability and Related Issues for Small Reactors
2.166.1	Ballooning of Heavily Hydrided Pressure Tubes (I)
2.168.1	Aging of CANDU Heat Transport Pressure Boundary Components
2.169.1	Reliability-Centred Maintenance Review of Safety Systems
2.170.1	Reliability of Electrical Motors under Accident Conditions
2.171.1	Portable Information Processing for Quality Assurance Audits
2.172.1	Computer-Based Safety Interlocks for Research Accelerators
2.174.1	Hydrogen Absorption-Desorption at Metal Surfaces
2.175.1	Pump Cavitation and Piping Vibration (I)
2.176.1	Software Functional Requirement Specification Techniques

2.177.1 Fuel Channel Refilling: Data Analysis
2.178.1 Critical Heat Flux Measurements in a Simulated Fuel Bundle
2.179.1 Performance of Steam Generator Emergency Water Injection
2.180.1 Testing Methods for Charcoal Filters
2.181.1 A Computer Program for Assisting Emergency Response Decisions
2.182.1 Human Performance Monitoring in Nuclear Power Plant

3. OTHER FUEL CYCLE FACILITIES, GENERAL

3.101.2 Demonstration of the Feasibility of Directly Dating Quartz (2)
3.103.1 Absorbed Fraction of Ingested Uranium in Humans
3.106.3 Transfer of Radionuclides to Human Milk - Phase 3 Pilot Study
3.111.1 Evaluation of Data and Models on Uranium Metabolism - Europe
3.111.2 Evaluation of Data and Models on Uranium Metabolism - North America
3.115.2 Neutron Dosimeters and Survey Meters in Accelerators (II)
3.121.1 BIOMOVS - Intercomparison of Environmental Assessment
3.121.2 BIOMOVS International Meeting, Ottawa, 1989
3.123.1 Influence of Macrophages on Dissolution of Uranium Compounds
3.124.1 Assessment of Errors in Airflow Measuring Instruments (U Mines)
3.125.1 Study of Chemical Toxicity of Uranium Hexafluoride
3.128.1 Fault Investigation - Miramichi Area, N.B.
3.130.2 Neotectonics in Nova Scotia - Phase 2
3.131.2 Neotectonic Investigations in Southern Ontario - Phase 2
3.132.2 Relocation of Seismic Events - Phase 2
3.132.3 Relocation of Seismic Events - Phase 3
3.133.1 Carbon-14 in Food and in Excretions
3.134.1 RBE from a Microdosimetric Approach
3.135.1 Measurement of Tritium in Canadian Food Items
3.136.1 Study of Birth Defects around Canadian Nuclear Facilities
3.139.1 Offset River Terraces in the Charlevoix Seismic Zone
3.140.1 Convoluted Laminations - A Literature Review
3.141.1 Microseismic Monitoring in the Miramichi Area, N.B.
3.142.1 Stresses to Induce Seismicity in the Miramichi Area
3.144.1 Paleoseismicity in the Chicoutimi Area
3.145.1 Significance of Urban Pathway in Assessing Public Dose
3.146.1 Canadian Atmospheric Stability Indicators
3.147.1 Field Testing of LiF (Mg, Cu, P) TL Dosimeters
3.148.1 Thorium Metabolism and Dosimetry - Literature Review

4. URANIUM MINES AND MILLS

4.101.1 Study of the Health Effects of Inhaled Uranium Ore Dust
4.103.2 Physical Characteristics and Solubility of Long-Lived Airborne Particulates in Uranium Producing and Manufacturing Facilities
4.106.3 Ontario Miners Mortality Study - Phase III
4.108.1 Intercomparison of Dust Sampling Instruments
4.112.1 Electrical Charge of Radioactive Aerosols in Uranium Mines
4.113.1 Tracer Gas Method for Assessing Ventilation Efficiency
4.116.1 Remote Control and Automation in Heavy Industry

4.117.1	Evaluation of Long-Lived Dust Exposures from Silica Samples
4.118.1	Evaluation of Exposure Records of Eldorado Uranium Miners
4.118.2	Mortality Analysis of Beaverlodge Uranium Miners from 1981-1987
4.119.1	Evaluation of Mine Ventilation Monitoring Devices
4.120.1	Sensitivity of Bronchial Epithelial Cells to Alpha Radiation
4.121.2	The Proliferative Cells of the Human Bronchial Epithelium
4.124.1	Improved Statistics for Uranium Miners Epidemiology Studies
4.125.1	Exposure Rate Effectiveness for the Induction of Lung Cancer
4.126.1	Computerized Mortality Search Procedures
4.127.1	Rapid Determination of Radon Daughter Concentrations

5. WASTE MANAGEMENT

5.115.1	Software Quality Assurance for Waste Disposal Models
5.119.1	Uncertainty in the Interpretation of Hydrogeologic Data
5.121.1	Calibration/Validation of FEMWATER/FEMWASTE on the Nordic Site
5.125.1	Coupled Processes in the Assessment of Deep Disposal
5.127.1	Radionuclide Concentrations in Fish: Serpent River Basin
5.129.1	Decommissioning of Open Pit Mines - Literature Survey
5.130.1	La Liquéfaction des Résidus de l'Uranium

6. NON FUEL CYCLE APPLICATIONS

6.102.1	Radiation Doses to Technologists from Radiotherapy
6.103.1	Beta-Gamma Counting of Ra-228/Ac-228 in Urinalysis
6.104.1	Production of a Hospital Radiation Safety Officer's Handbook
6.105.1	Radiation Exposures of Non-Monitored Hospital Personnel
6.110.1	Dispersion from Fume Hood Exhaust Stack

7. HEALTH PHYSICS

7.093.1	Epidemiology of Lung Cancer Mortality in Canadian Mining Communities
7.093.2	Epidemiology of Lung Cancer in Canadian Mining Communities (2)
7.101.1	The Canadian National Dose Registry Study
7.106.2	Effects on Central Nervous System from In Utero Exposure
7.110.1	Screening of Human Populations for Abnormal Radiosensitivity
7.111.1	In Vitro and In Vivo Studies of the Effects of Ionizing Radiation on the Developing Central Nervous System
7.116.1	Cancer Morbidity Follow-Up Feasibility Study
7.117.1	Hospital Record-Keeping System for Epidemiological Studies
7.118.1	Selection of Control Groups for Epidemiological Studies
7.119.2	Full-Scale Epidemiological Study of Thyroid Cancer from I-131 Exposure
7.121.1	Cancer Mortality among Cardiac Catheterization Patients
7.122.1	Computerized Linkage of National Cancer Incidence Data
7.126.1	Use of An Employee Identification Questionnaire and Guide
7.127.1	Dose Response of Human Lymphocytes to Radiation and Chemical Carcinogens

7.128.1	The Relative Impact of Radiation-Induced Genetic Disorders
7.130.1	Ionizing Radiation in Tumour Promotion or Progression
7.131.1	MOSFET or Silicon Diode Based Personal Beta Dosimeters
7.132.1	Computerized Format for Pooling Radiation Exposure Records
7.133.1	Bone Cancer from Radionuclide Intake
7.134.1	Threshold Effect of CNS Defects Due to In Utero Exposure
7.135.1	Mechanism of Radiation-Induced Mental Retardation
7.136.1	Confounding Factors Associated with Breast Cancer Incidence
7.137.1	Study of Childhood Cancer following Maternal X-Irradiation
7.141.1	RBE of Gamma Rays Delivered at Low Dose Rates
7.142.1	Mortality Analysis of the Fluorspar Miners from 1985-1988
7.143.1	Canadian Cancer Data Base
7.144.1	Development of an "Index of Harm" for Canadian Workers
7.145.1	Screening Breast Cancer Patients for A-T Heterozygosity
7.146.1	Effects of Radiation on Wild Birds Breeding: Tree Swallows
7.147.1	Contribution to Statistics Canada Workshop

8. TRANSPORTATION

8.103.1	Testing of Foam Used in Packaging for Shock and Thermal Absorbency

9. REGULATIONS & REGULATORY PROCESS DEVELOPMENT

9.102.1	Review of Crisis Management Methods
9.103.1	Study of the AECB Long Range Plan for Information Management (I)
9.103.2	Implementation of a New File Classification System
9.103.3	Implementation of New Information Management Plan
9.104.1	Regulatory Effectiveness Measurement System
9.106.2	A Review of the UCP System
9.112.1	Management of Risks & Socio-economic Impacts of Technology

STANDARD ABBREVIATIONS AECB ORGANIZATIONAL UNITS

SIGLES COURANTS DES UNITÉS ORGANISATIONNELLES DE LA CCEA

Office of the President	OPR	Bureau du Président
Advisory Committee on Radiation Protection	ACRP	Comité consultatif de la radioprotection
Advisory Committee on Nuclear Safety	ACNS	Comité consultatif de la sûreté nucléaire
Secretariat	SEC	Secrétariat
Secretary to the Board	SEB	Secrétaire de la Commission
Office of Public Information	OPI	Bureau d'information publique
Advisory Committee Secretariat	ACS	Secrétariat des groupes consultatifs
Legal Services Unit	LSU	Services juridiques
Official Languages Advisor	CLO	Conseiller en langues officielles
Medical Liaison Officer	MLO	Agent de liaison médical
Director of Reactor Regulation	DRR	Direction générale, Réglementation des réacteurs
Safety Evaluation Division	SED	Division, Évaluation de la sûreté
Components and Quality Assurance Division	CQAD	Division, Composants et assurance-qualité
Power Reactor Division A	PRDA	Division A, Réacteurs de puissance
Power Reactor Division B	PRDB	Division B, Réacteurs de puissance
Operator Certification and Research Facility Division	OCRFD	Division, Accréditation des opérateurs et établissements de recherche
Directorate of Fuel Cycle and Materials Regulation	DFC	Direction générale, Réglementation des matières nucléaires et des radioéléments
Office of Safeguards and Physical Security	OSS	Bureau des garanties et de la sécurité matérielle
Safeguards and Security Division	SSD	Division, Garanties et sécurité
Radioisotopes and Transportation Division	RTD	Division, Radio-isotope et transports

Compliance Services and Laboratories Division		CSLD	Division, Contrôles et laboratoires	
Uranium Mine Division		UMD	Division, Mines d'uranium	
Waste Management Division		WMD	Division, Gestion des déchets	
Fuel and Heavy Water Plant Division		FWD	Division, Usines de combustibles et d'eau lourde	
Planning and Administration Branch		PAB	Direction, Planification et administration	
Planning and Coordination Section		PCS	Section, Planification et coordination	
Administration Division		ADD	Division, Administration	
Finance Section		FIS	Section, Finances	
Personnel Section		PES	Section, Personnel	
Information Management Section		IMS	Section, Traitement de l'information	
Research and Radiation Protection Branch		RRB	Direction de la recherche et de la radioprotection	
Radiation Protection Division		RPD	Division, Radioprotection	
Health and Environmental Effects Section		HES	Section des effets sur la santé et l'environnement	
Safety and Safeguards Section		SSS	Section, Sûreté et garanties	
Editorial Support Services (OPI)		SAR	Service d'appui à la rédaction	
Project Office	- Bruce	POB	Bureau de projet	- Bruce
	- Darlington	POD		- Darlington
	- Gentilly	POG		- Gentilly
	- Point Lepreau	POL		- Point Lepreau
	- Pickering	POP		- Pickering
Laboratory		LAB	Laboratoire	
Regional Offices:			Bureaux régionaux:	
Central Region		CRO	Région central	
Eastern Region		ERO	Région de l'Est	
Southern Ontario Region		SORO	Région du Sud de l'Ontario	
Western Ontario Region		WRO	Région de l'Ouest	
Elliot Lake		ELO	Elliot Lake	
Accommodation and Material Management		AMM	Gestion des locaux et du matérial	
Records Office		REC	Bureau des documents	

Library	LIB	Bibliothèque
Administrative Support Group (Floor)	AS4 AS5 AS6 AS7 AS8	Groupe de soutien administratif (Étage)